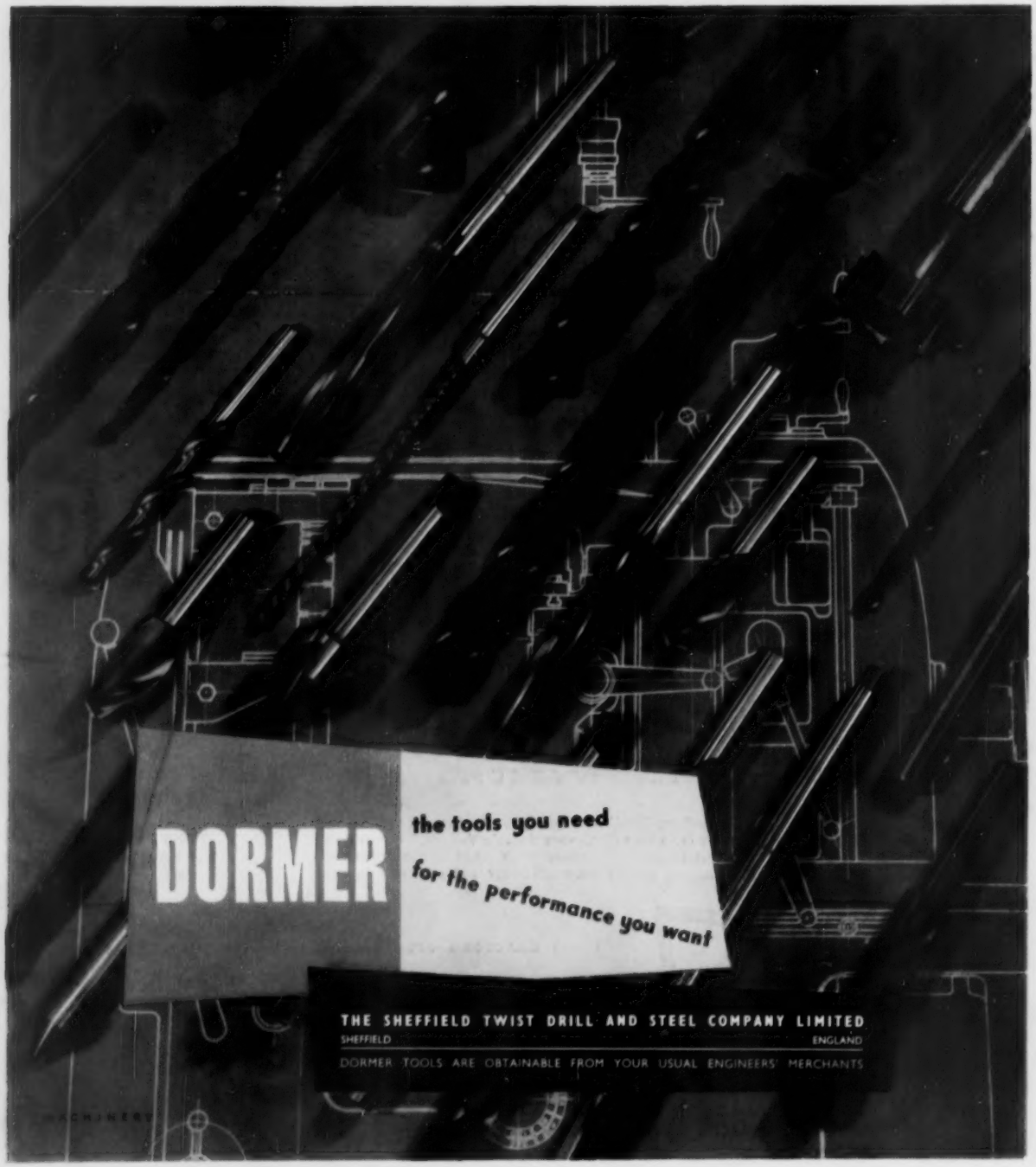
AUTOMOBILE ENGINEER

DESIGN · PRODUCTION · MATERIALS

Vol. 45 No. 4 APRIL 1955 PRICE: 3s. 6d.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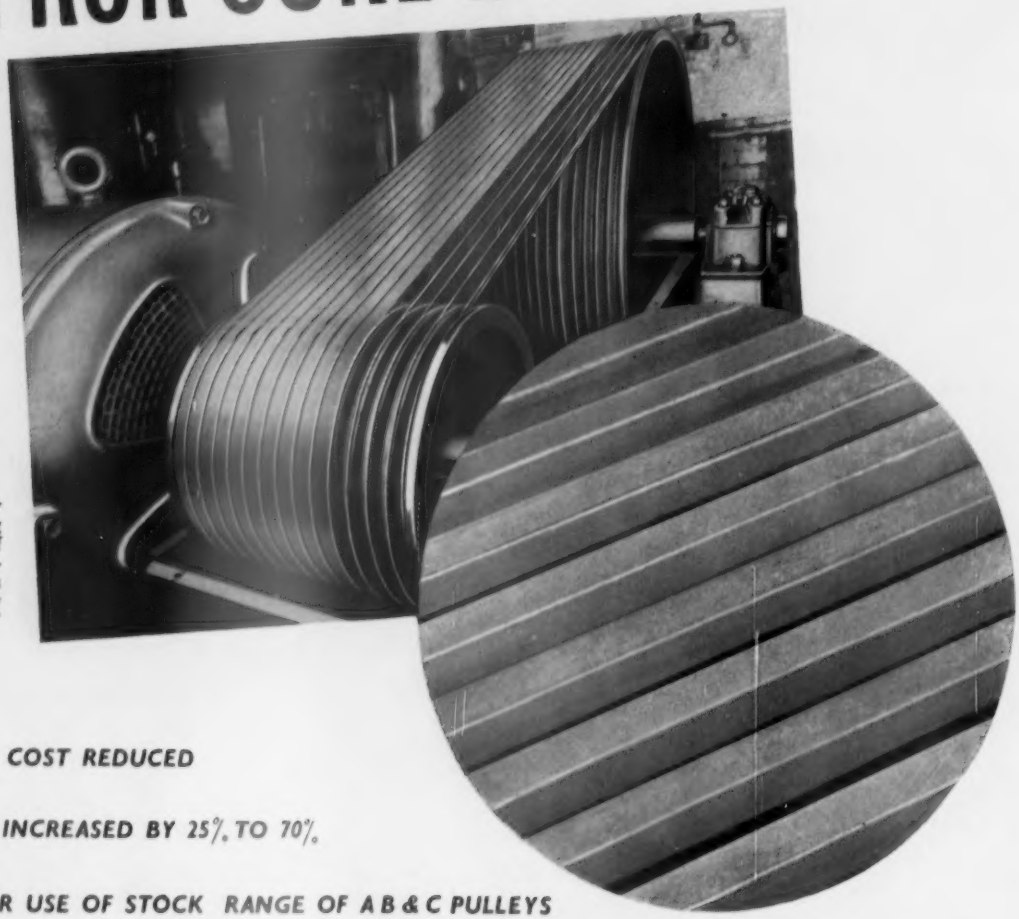

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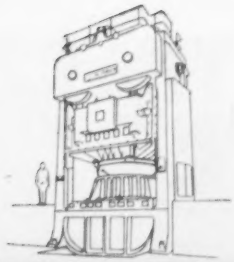

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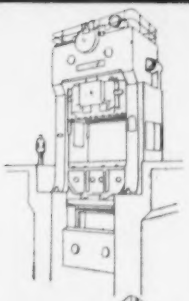

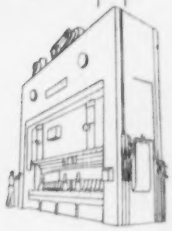

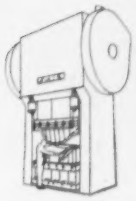

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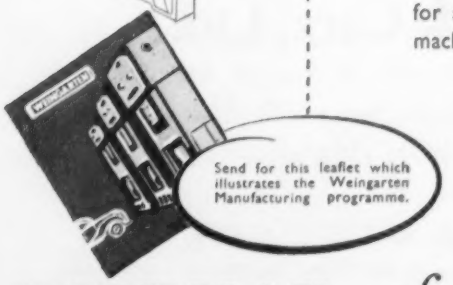

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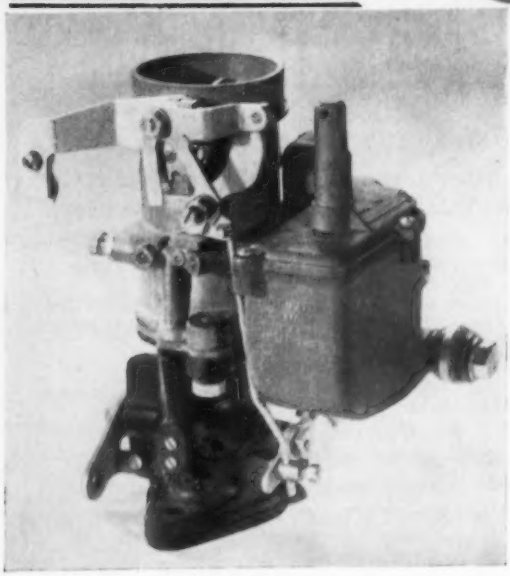

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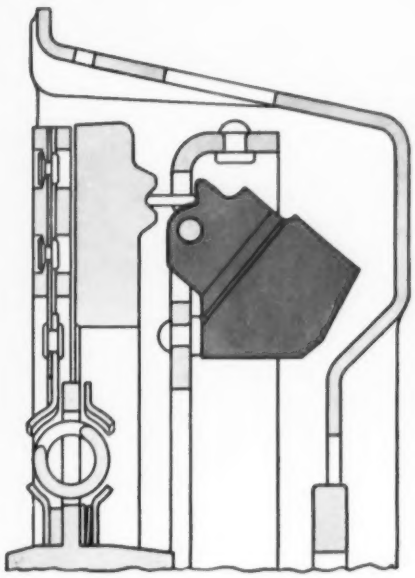
TRANSMISSION CONSIDERATIONS 11

The Centrifugal Clutch



At this stage in our series of brief essays, perhaps it will be accepted that certain aspects of clutch design can be helpful in solving some transmission problems which originate elsewhere in the vehicle.

Recently we noted that the spring segments of a Borglite plate can minimise certain faults which are apt to show themselves when a vehicle starts from rest. Similarly, our latest note showed that suitable choice of clutch centre can do much to improve transmission behaviour at all speeds. On several earlier occasions it was remarked that certain difficulties could be avoided by the use of a centrifugal clutch. As this device, like so many things, is not quite so simple as it may seem, let us now discuss some of its features.

The primary reason for its existence is, of course, to provide automatic engagement and release. In this way, it relieves the driver of the need for co-ordination of clutch pedal and accelerator. Besides this simplification of driving technique, however, it has some valuable incidental effects.

As in the fluid flywheel, the driving torque transmissible by a centrifugal clutch is proportional to some function of the speed. Centrifugal force itself of course is proportional to the square of the speed but its effect on the clamping force may be altered by the leverage system employed.

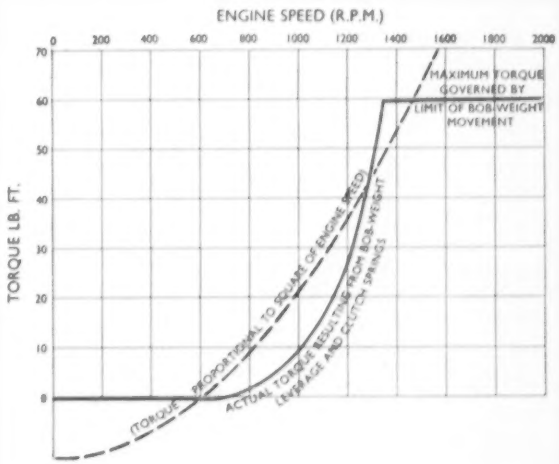
A simple bob-weight arrangement can be used and this does give a square-law relationship. However, this characteristic is not ideal. As we have already seen, it is desirable that the initial engagement of the friction faces (and thus the absorption of backlash) shall occur while the applied torque is as small as possible. In conjunction with a petrol engine, this means that the initial engagement must occur at very modest crankshaft speeds. On the other hand, the clamping force must remain light until the engine speed has risen to a point at which the developed torque is adequate to move the vehicle from rest.

A piece of metal such as the bob-weight in a centrifugal clutch produces a force proportional to the square of its rotational speed. It is this force that is utilised for clamping the driven plate and producing the driving torque. Unfortunately, however, the rate of increase of this force is rather high at speeds in excess of the normal engine tick-over speeds. For this reason it is desirable to modify the bob-weight lever system to provide a gradual increase in the initial torque followed by a more rapid increase up to the predetermined maximum. Curves on this page illustrate the effect of the lever modification on the plain square-law curve of centrifugal force.

As so often in engineering problems, this modification demands some judgment. There must be compromise because the spread of take-up is limited by the need to avoid clutch slip at the lowest speed at which the engine would be run under load.

Two important incidental advantages accompany the use of a centrifugal clutch. One is that clutch control requires no connection between the power unit and the chassis. This in itself eliminates various troubles mentioned earlier, particularly in connection with judder. For that reason, if for no other, the centrifugal clutch represents a big advance.

Secondly, there is the fact that the engine governs the clutch and not *vice versa*. Because take-up is automatic, the clutch is always working under optimum conditions. It suffers no abuse, conscious or otherwise. Consequently, as service records show, the life of the friction facings is always better in a centrifugal clutch than in one that is controlled directly by the driver.



This concludes the series of articles on transmission considerations by

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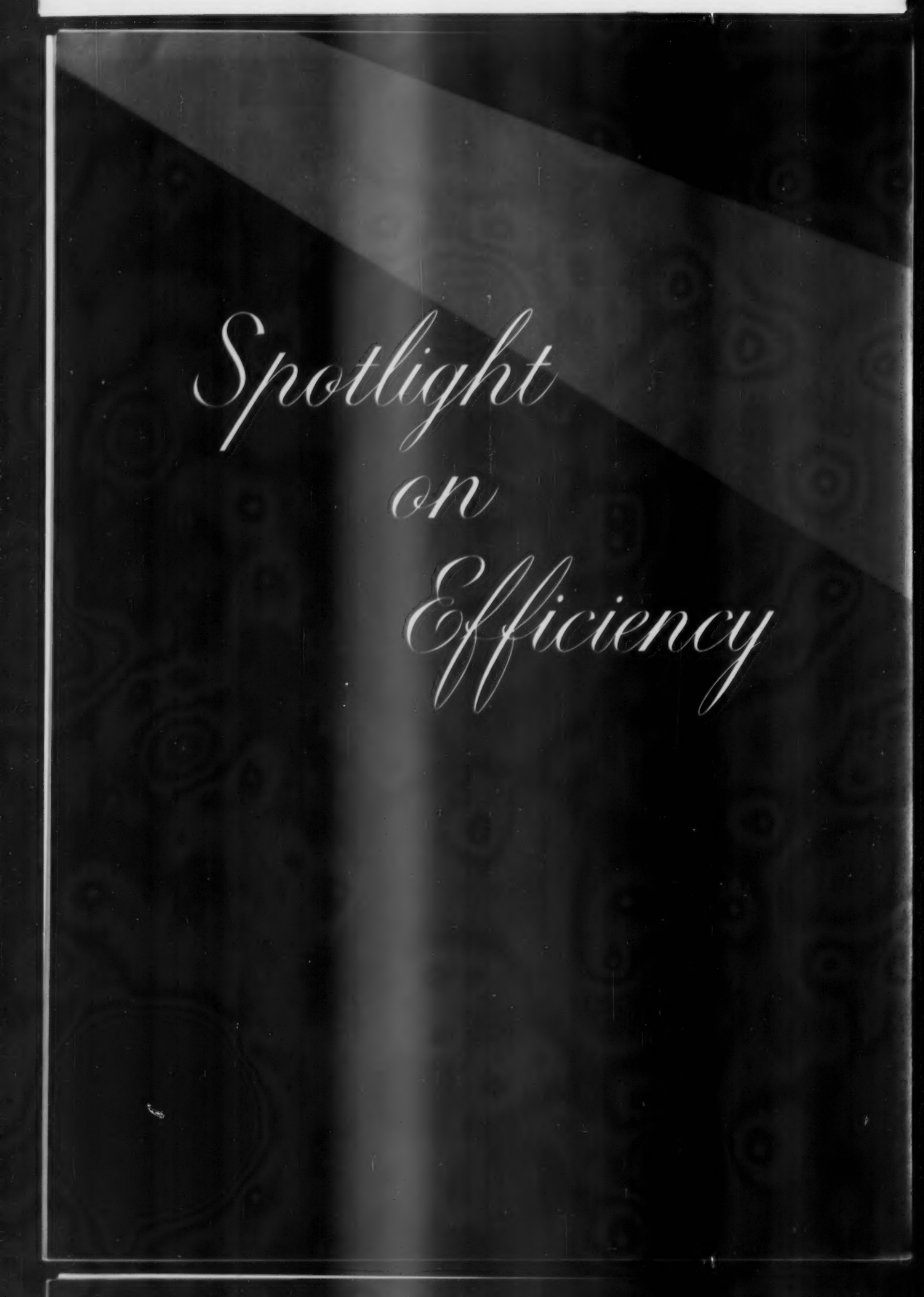
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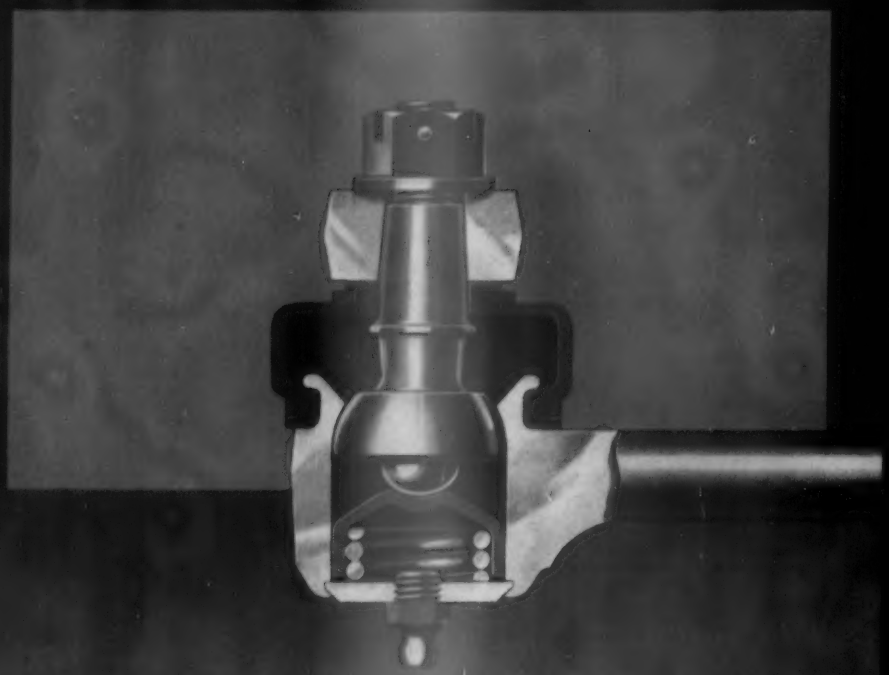

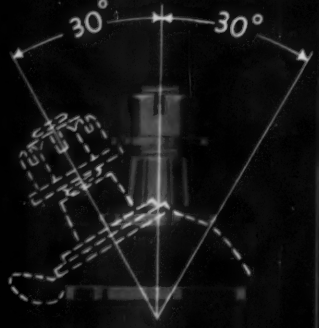

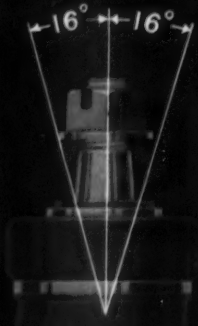

The illustration shows a size 'A' dual-type ball joint and fixed one-piece side rod. This is used in conjunction with an adjustable centre rod. This three-rod system is used extensively on popular British small and medium-sized cars of modern design.

The adjustable centre rod has left-hand and right-hand threading to the ball joint assemblies, thus providing a simple adjustment which is effected by unlocking the locknuts on the ball joint assemblies and turning the intermediate bar to correct toe in or toe out.

In addition to the 'A' size, which is suitable for front axle laden weight of approximately 11¼ cwt., there are two sizes; 'B', suitable for front axle laden weight of approximately 11¼ to 16 cwt., and size 'C', suitable for front axle laden weight of approximately 16 to 21 cwt.

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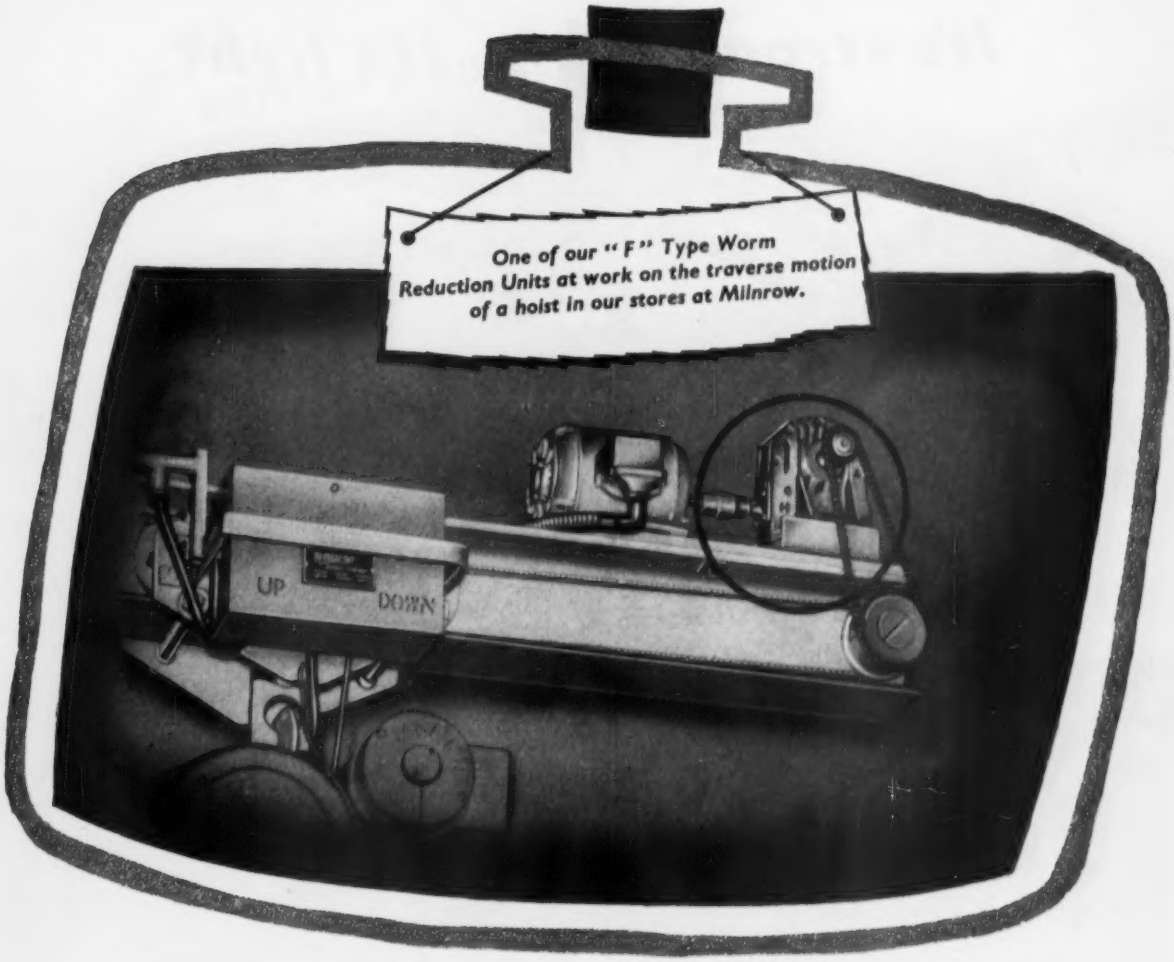

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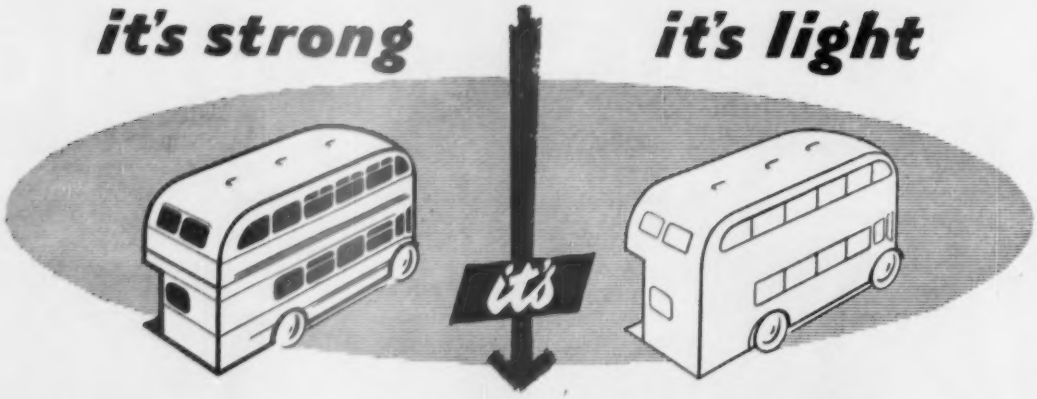

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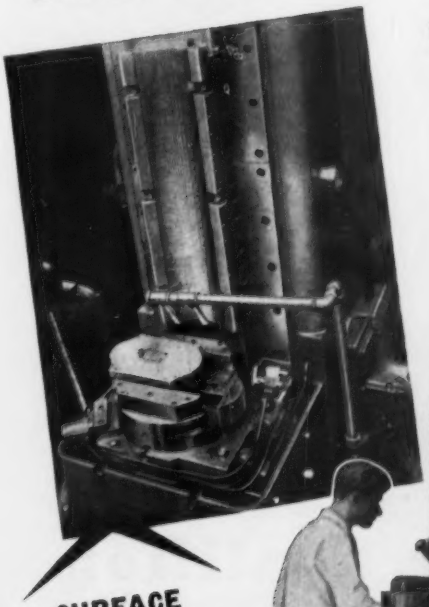

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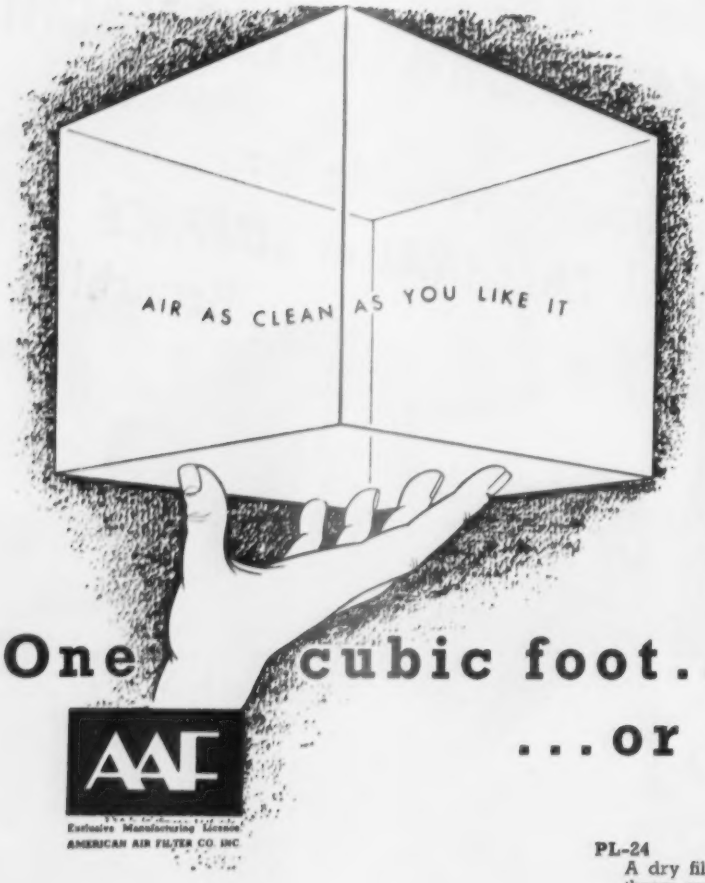

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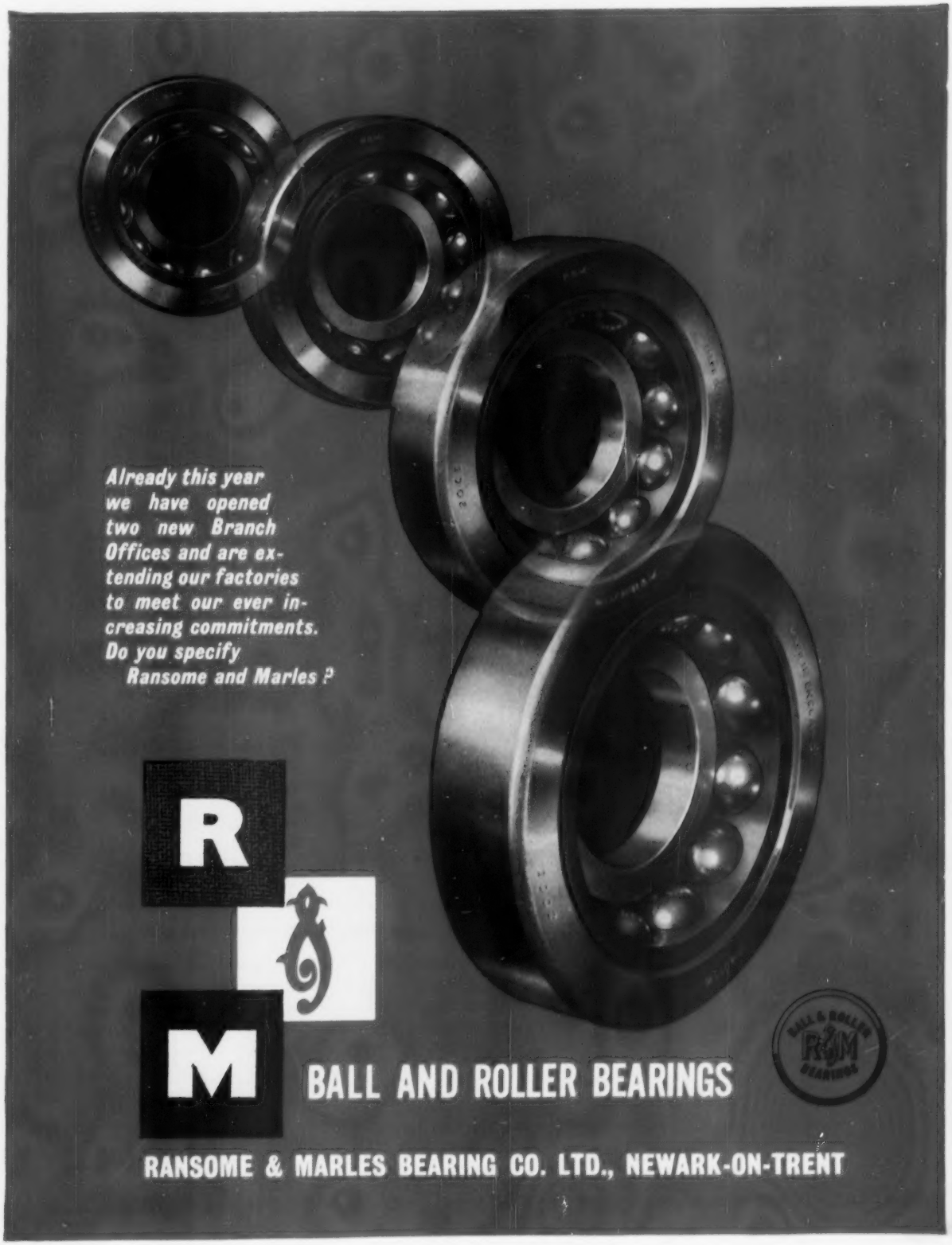
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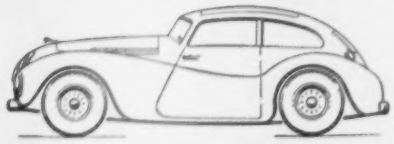

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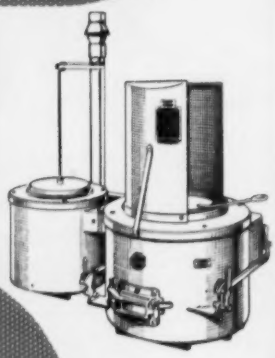

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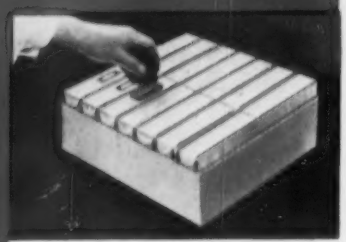

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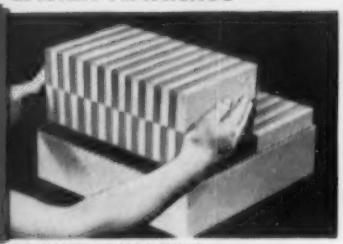

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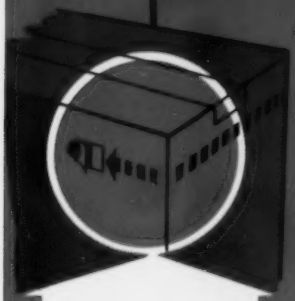

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NEW 2 TONE STOVING FINISH

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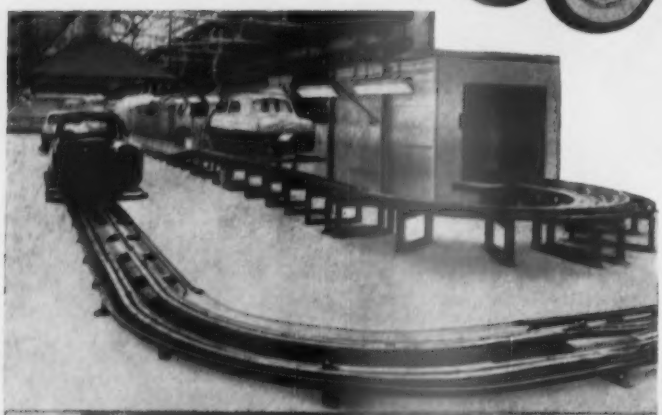

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Infra-red equipment

Briggs Motor Bodies Limited, of Dagenham are pioneers of two-tone stoving on cars. They have installed this new battery of Metrovick infra-red element projectors for stoving the lower section of the Ford luxury car, the Zodiac.

Ordinary convection heating of the enamel resulted in the top half—already stoved in a lighter colour—becoming discoloured through re-heating. The localised infra-red oven, planned in conjunction with Metrovick engineers, has been entirely successful. Each body takes 15 minutes to pass through the oven which is 120 ft. long and has a total installed load of 664 kW.

All British Ford cars are synthetic enamel stoved for a better and more durable finish.

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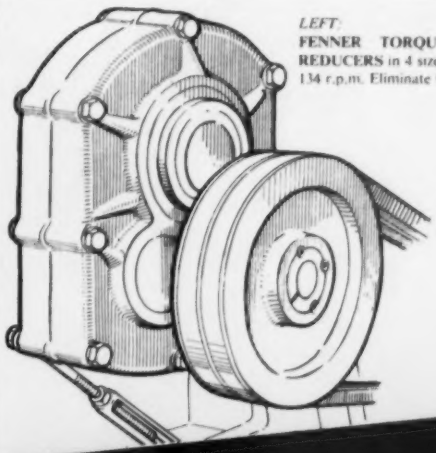
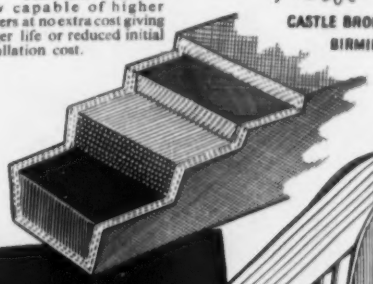


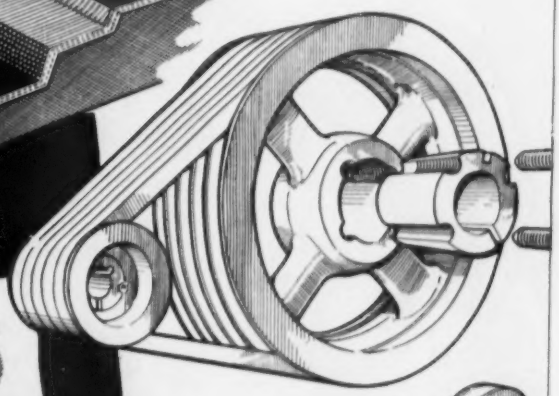
LEFT:
FENNER TORQUE-ARM SHAFT MOUNTED SPEED REDUCERS in 4 sizes up to 12 H.P. with output speeds from 9 to 134 r.p.m. Eliminate bed plates, couplings and lining up difficulties.

B I F O 2-13 May
CASTLE BROMWICH BIRMINGHAM

RIGHT:
FENNER V-BELTS now capable of higher powers at no extra cost giving longer life or reduced initial installation cost.



BELOW:
FENNER V-BELT DRIVES with Taper-Lock Pulleys for drives up to 75 H.P. Taper-Lock bushes provide the simplest method of pulley changing. Comprehensive range of sizes for A, B and C V-Belts.



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We shall be pleased to meet you on Stand D406 for the opportunity of discussing your Power Transmission problems. Apart from the products illustrated Fenner will be exhibiting many others that increase power transmission efficiency and reduce operating costs.
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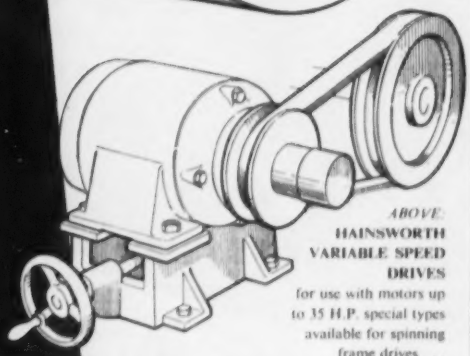

ABOVE:
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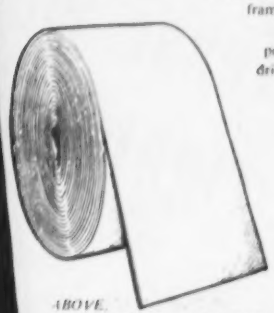

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Anywhere a nut works loose you need a Simmonds self-locking nut. It may be a Nyloc, or a Fibre Nut with fibre insert, or a Pinnacle Nut with metal diaphragm. We'll be glad to tell you which is best for your particular job.

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Space is valuable. No cams to make and store, slices overheads.

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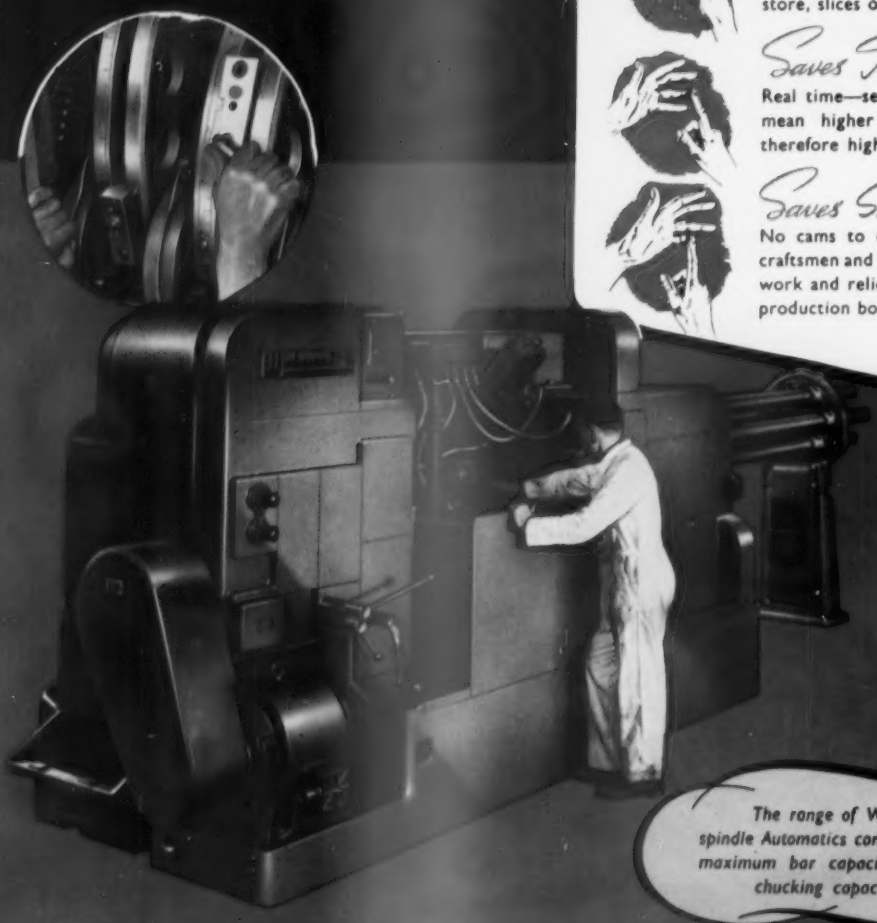
Real time—set-up time. Savings which mean higher machine utilisation and therefore higher profits.

Saves Skill

No cams to design and make, releases craftsmen and tooling engineers for other work and relieves the cause of frequent production bottlenecks.



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WICKMAN LIMITED

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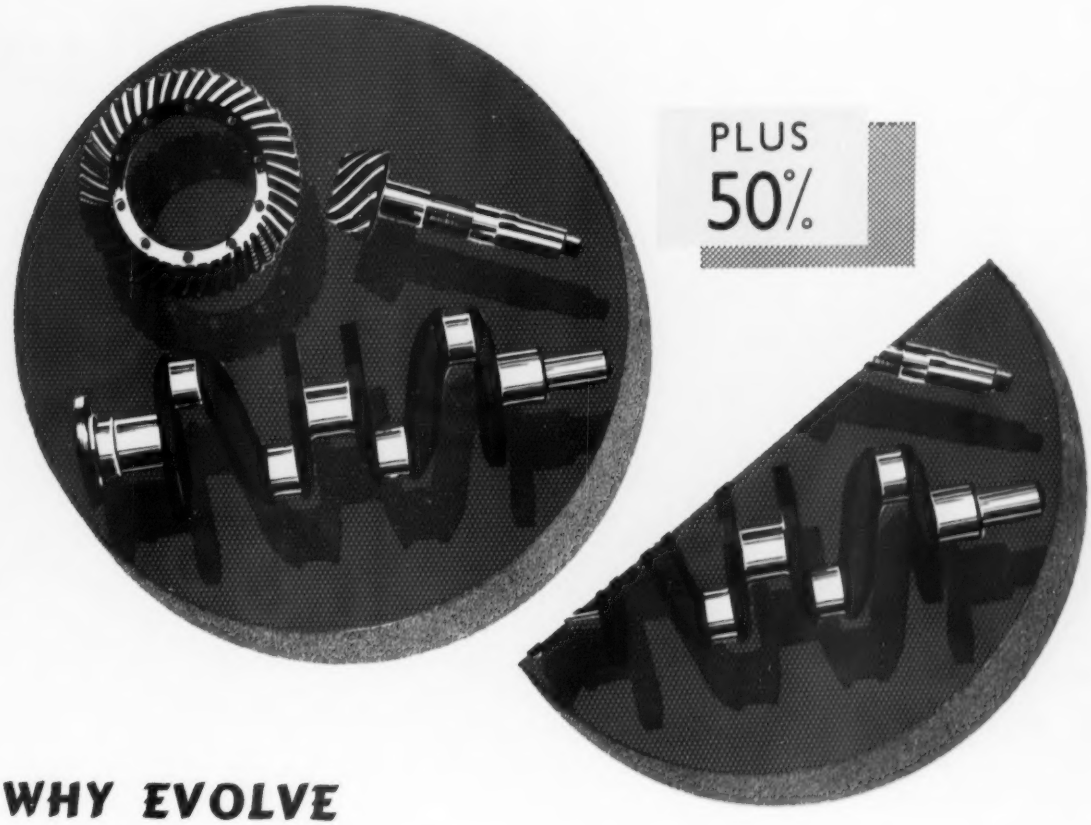
MOLYBDENUM'S PLACE IN INDUSTRY



WHY EVOLVE NEW STEELS?

Among others, the automobile industry plans a vast increase in production, but the supply problem is not solved simply by ordering 50% more of the important alloy steels.

For every one of these steels is dependent upon the alloying elements used in it, and the serious shortage of even one of them prohibits expansion on present lines.

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Molybdenum is an alloying metal chiefly used in small quantities to improve the physical properties of steel.

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The Laycock-de Normanville Overdrive is available on the following cars :— Austin Healey, Bristol 405, Doretti, Humber Hawk, Jaguar Type 'M', Jaguar XK140, Jensen Interceptor and 541, Sunbeam Alpine, Standard Vanguard and Vanguard Diesel, Sunbeam Mk. III, Triumph Renown, Triumph T.R.2.

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It's British

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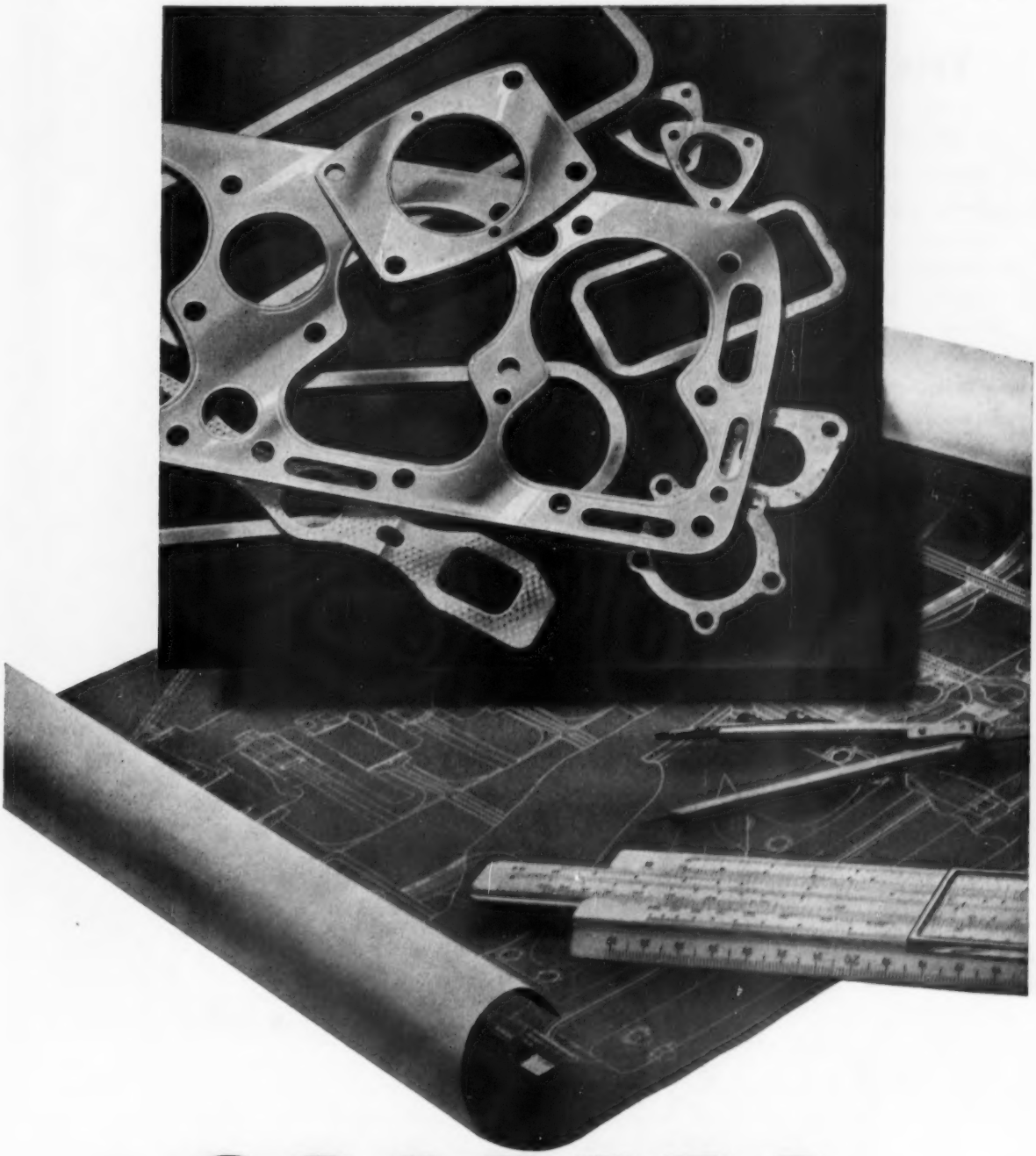

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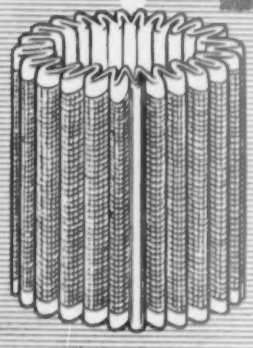

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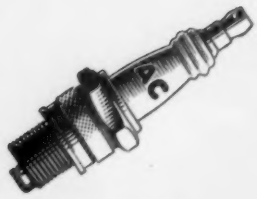

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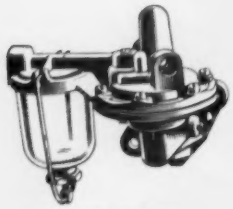

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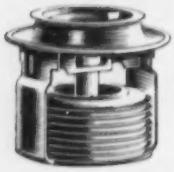

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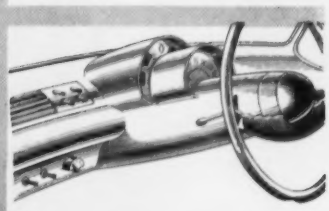

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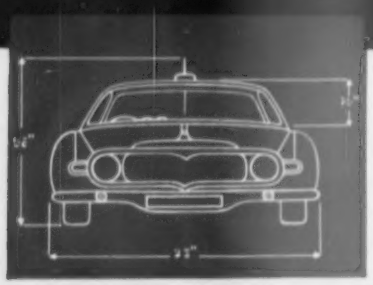

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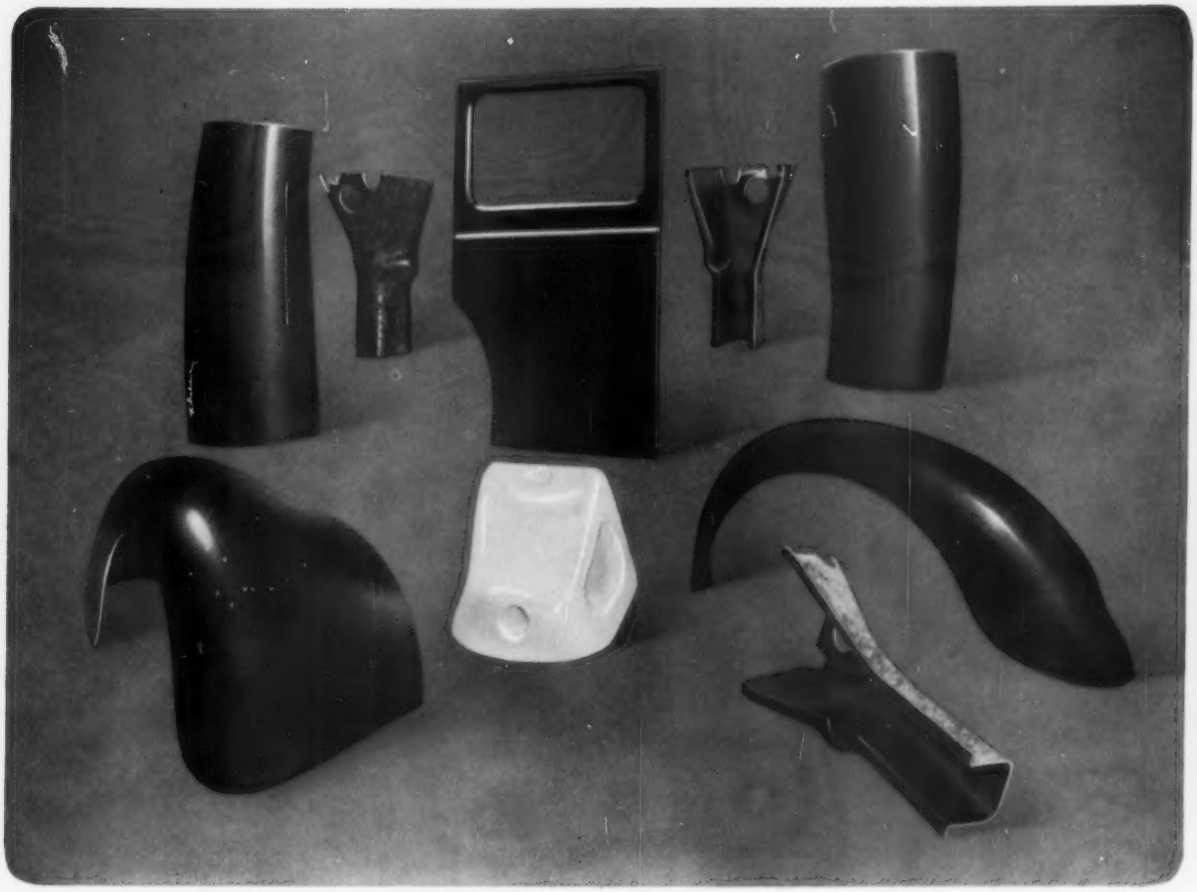

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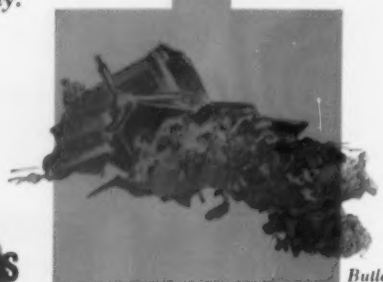

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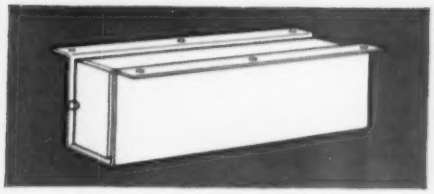

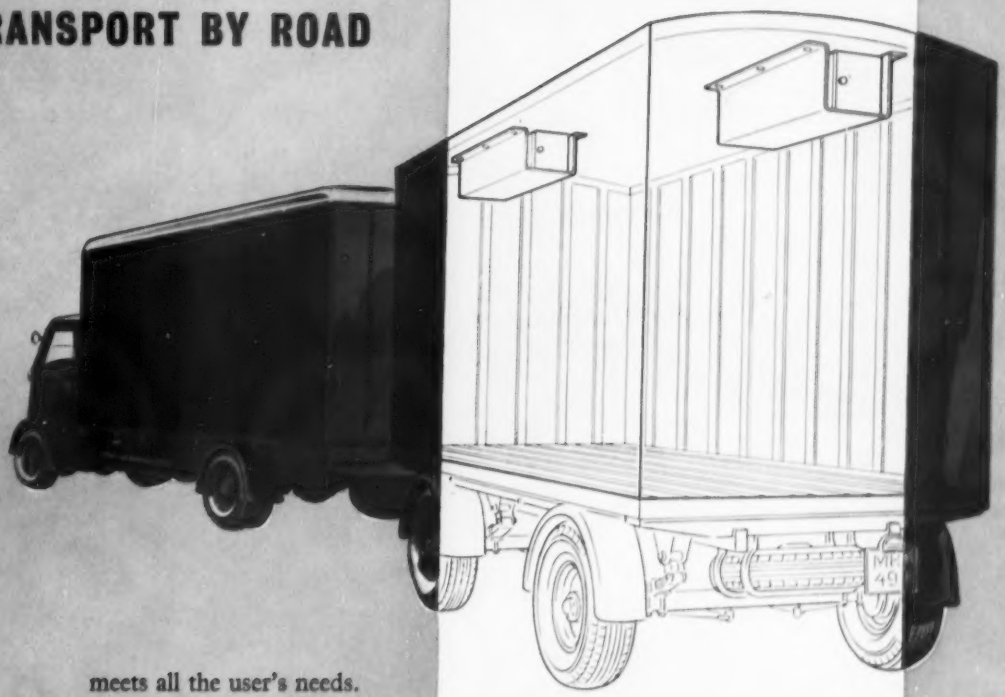

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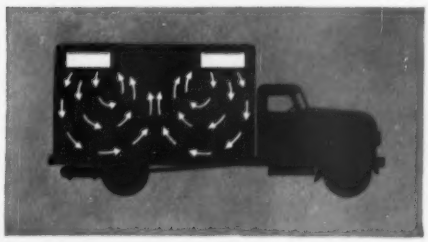

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'DRIKOLD' **the solid carbon dioxide—dry ice—sold by Imperial Chemical Industries Ltd.**

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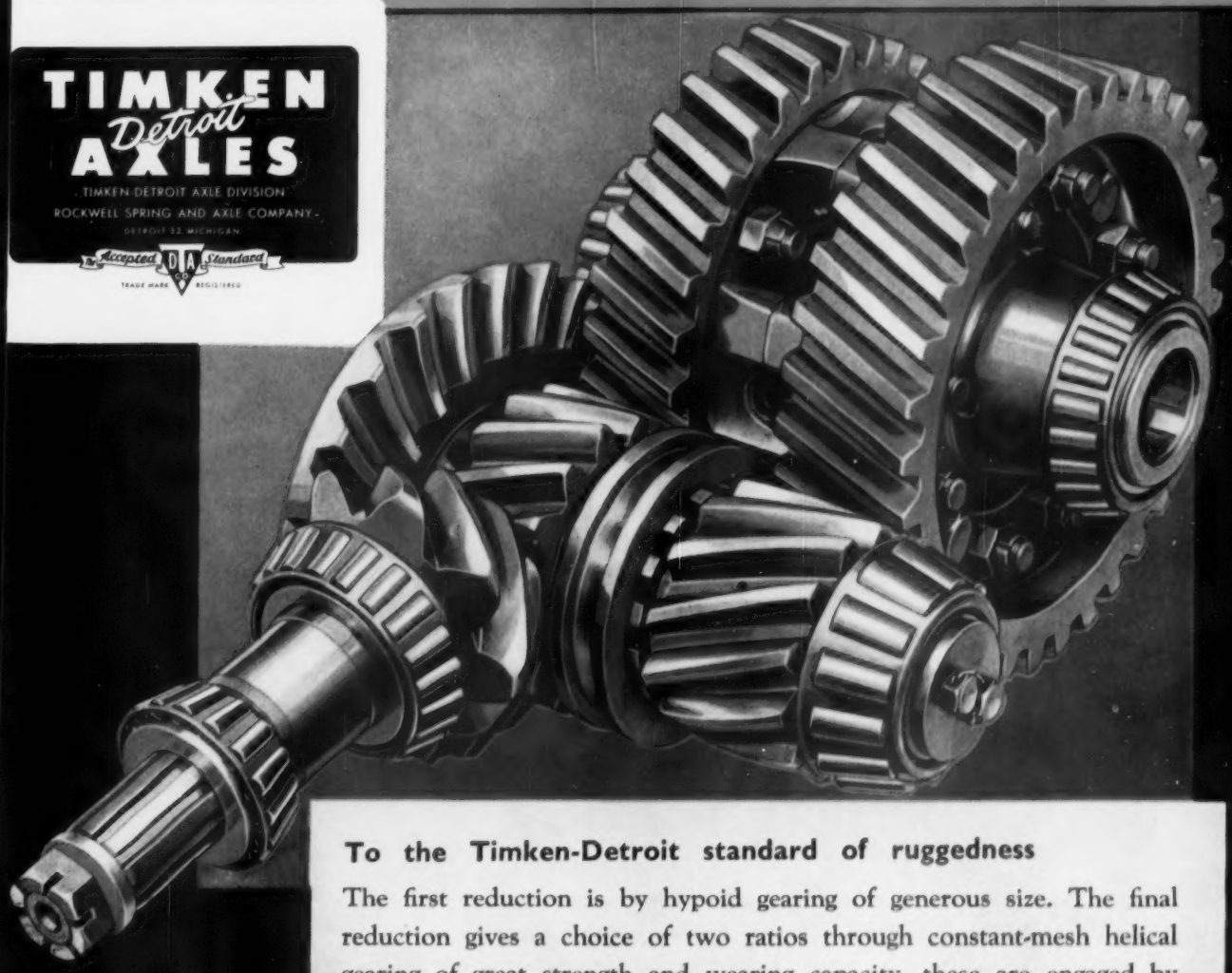

To the Timken-Detroit standard of ruggedness

The first reduction is by hypoid gearing of generous size. The final reduction gives a choice of two ratios through constant-mesh helical gearing of great strength and wearing capacity, these are engaged by robust dog-clutches.

High-duty Timken tapered-roller bearings: high-duty differential.

Brakes: hydraulic-dual primary or air-actuated.

Front axles are also available.

Exclusive European distributors for The Timken-Detroit Axle Division, Rockwell Spring and Axle Company, Detroit, Michigan, U.S.A.:—

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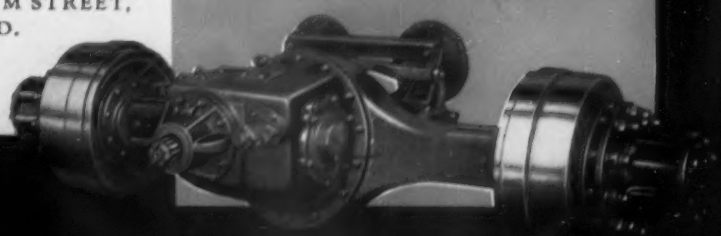
BROCK HOUSE, LANGHAM STREET,
LONDON, W.1, ENGLAND.

GUARANTEED AXLE-SHAFTS AND AXLE HOUSING

Timken-Detroit torsion-flow axle-shafts, heat-treated and shot-peened, are guaranteed for 100,000 miles of operation or for three years, whichever occurs first, against defective materials and workmanship. The forged axle housing is guaranteed for the life of the vehicle.

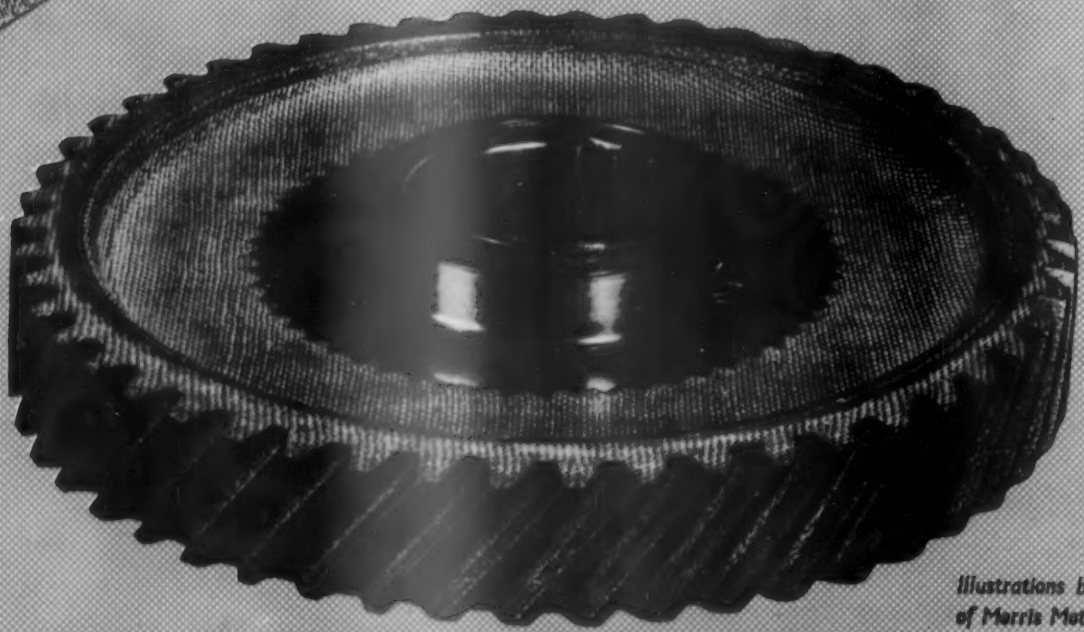


RE-INFORCED MOULDINGS

better in TEXOLEX

RE-INFORCED PLASTICS

The illustrations show a sectioned gear blank and the finished spur gear



Illustrations by courtesy of Morris Motors Limited

THE BUSHING CO. LTD., HEBBURN-ON-TYNE

G.K.N.

GUEST, KEEN & NETTLEFOLDS OF DARLASTON USE ALL TYPES OF

HERBERT PREOPTIVE CAPSTAN and TURRET LATHES

IN THEIR TOOLROOM.

THEY INCLUDE THE HERBERT No. 4 SENIOR CAPSTAN LATHES AND No. 7 and 8 COMBINATION TURRET LATHES. OTHER TYPES ARE ALSO IN CONTINUAL USE.

EXCEPTIONAL ACCURACY and, WHERE REQUIRED, HIGH DEGREE OF SURFACE FINISH ARE BEING OBTAINED.

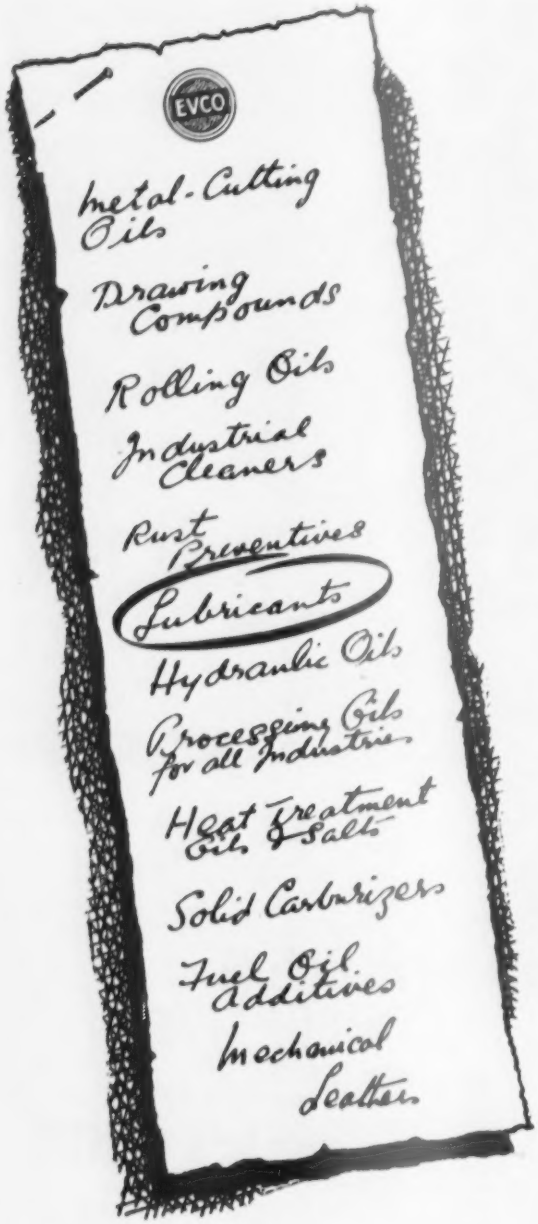
50% INCREASE IN PRODUCTION HAS BEEN EFFECTED OVER THAT OF PREVIOUS METHODS USING CENTRE LATHES AND OLDER TYPES OF CAPSTAN LATHES.

THE high quality of design, materials and workmanship of Herbert Capstan and Turret Lathes are the result of over 60 years' experience in their manufacture and application.

They are used throughout the world where efficient production, accuracy, durability and ease of operation are major considerations.

If samples or drawings of work to be machined are sent to us, we quote for the most suitable machines with all essential equipment and give reliable estimates of production.

ALFRED HERBERT LTD · COVENTRY



LUBRICANTS

We have long been associated with the development and supply of superior lubricants and as a result of close collaboration, many machine builders exclusively recommend the use of our products.

The importance of correct lubrication cannot be overemphasized and since relatively small amounts of lubricant are normally required, the adoption of the highest quality is strongly advocated. Refining and additive treatment have been developed to a degree whereby machine life can be extended and production speeds often increased by the use of our modern lubricants.

Our lubricants are designed to cover the specific requirements of industry and have solved many problems.

For the general lubrication of machine tools we recommend grades of oil belonging to the **COSMOLUBRIC** range and for precision spindle bearings an appropriate type of **KENSINGTON** spindle oil.

We have a series of oils called **VITAL E.P.** designed to meet most gear lubrication problems. Characterised by particularly high film strength and load-carrying capacity, **VITAL E.P.** is of low cold test, non-sludging and non-corrosive. The ability to resist leakage is exemplified in that celebrated range of lubricants appropriately called **STA-PUT.** When correctly applied leakage is almost non-existent, thus reducing oil consumption on open bearings and promoting cleanliness of machines and floors. **STA-PUT** will not gum, stain or rust and possesses great oiliness.

High Temperature Lubrication:

The lubrication of parts operating at elevated temperatures presents a special problem to which we have given close attention. This has resulted in the development of **HI-TEMP** oils—varieties are available for many different high temperature applications. In addition, a range of specialised lubricants for Die-casting machines is available.

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Crankshaft & Camshaft sprockets and chain as fitted to the Hillman-Minx. Morse ½" pitch single, duplex and triplex Roller Chains are available for all engine manufacturers.

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This is why famous manufacturers throughout the world specify Morse Chains for their equipment.

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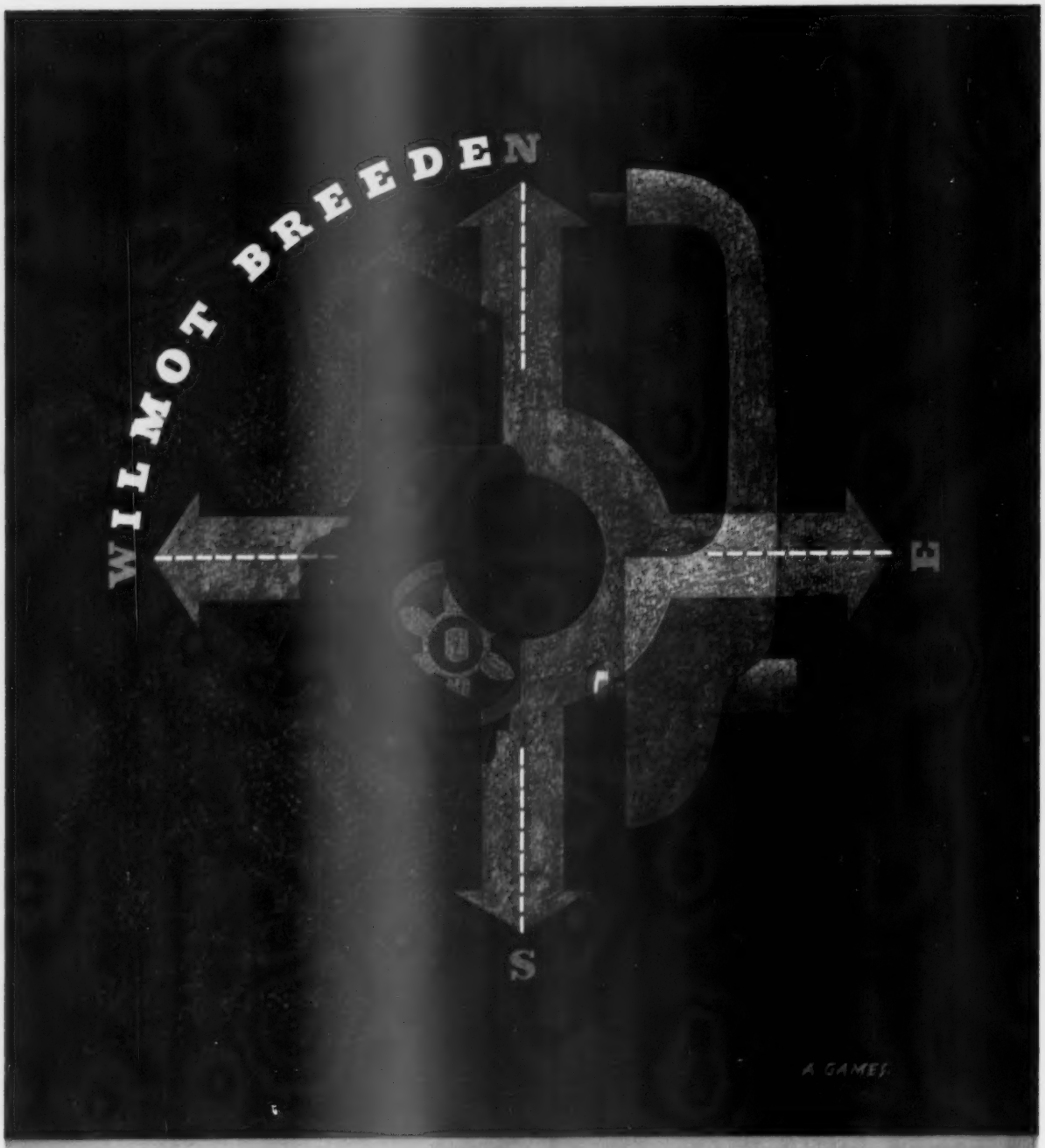
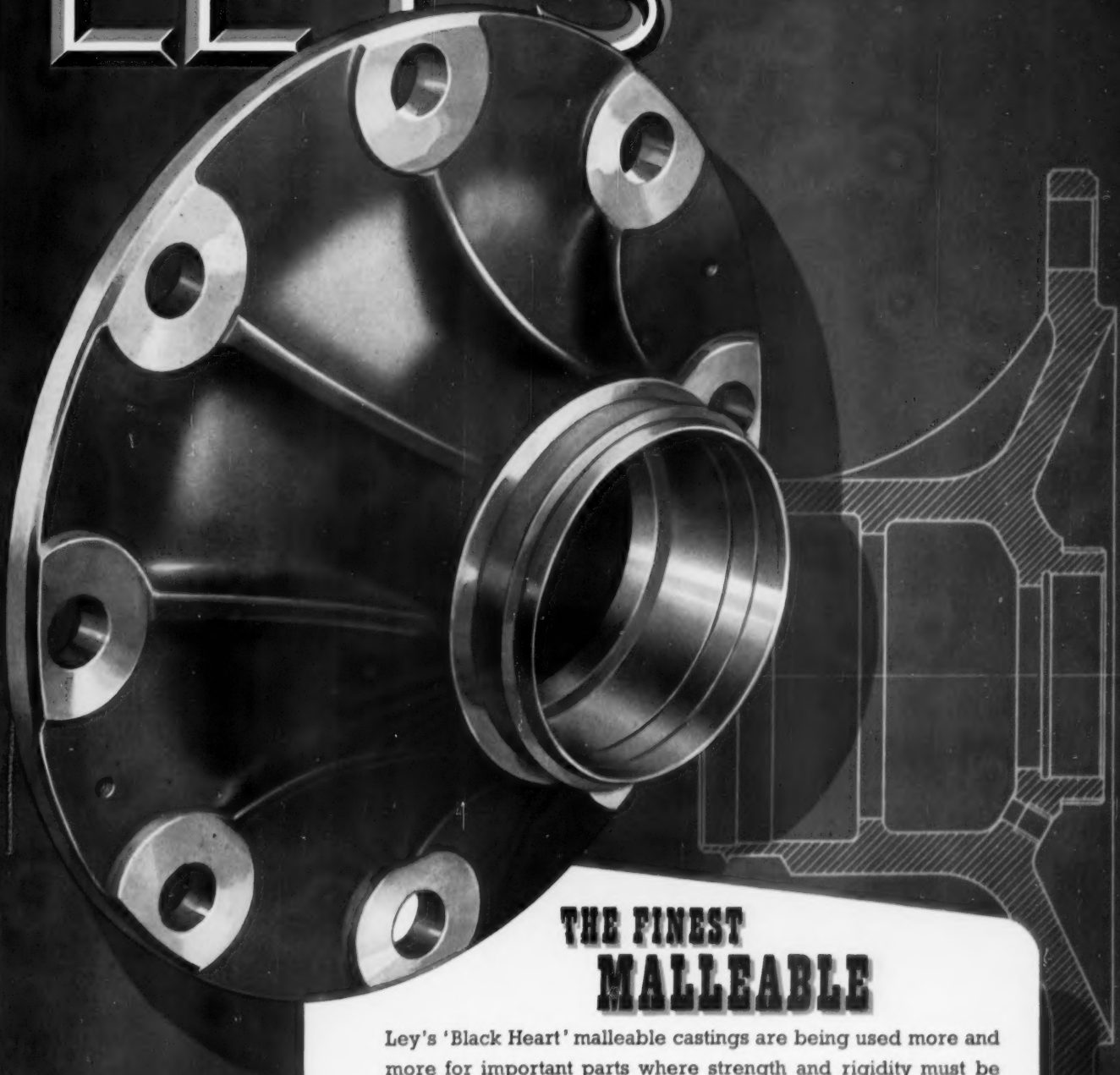


across the world Wilmot Breeden door locks and handles are giving constant, enduring service. The particular lock and handle forming the theme of this design were developed together to give such service, but with new standards of strength, elegance and quietness of action.

The strength of the push-button handle lies in its being *fixed* — and at both ends. But this demanded a new kind of lock, one which could be tripped by the thumb's limited movement and pressure. To achieve this two simple mechanical principles were used, the ratchet and the rack and pinion; these give easy release, a quiet action and complete door security.

WILMOT BREEDEN LTD BIRMINGHAM LONDON MANCHESTER GLASGOW

LEY'S



THE FINEST MALLEABLE

Ley's 'Black Heart' malleable castings are being used more and more for important parts where strength and rigidity must be combined with ease of machining. The illustration shows a front hub 12½" outside diameter, for a commercial vehicle.

LEY'S 'BLACK HEART' MALLEABLE CASTINGS:		LEY'S 'LEPAZ' MALLEABLE CASTINGS:	
Elongation:	18%	Elongation:	6%
Yield Point:	16 tons p.s.i.	Yield Point:	21 tons p.s.i.
Tensile Strength:	24 tons p.s.i.	Tensile Strength:	35 tons p.s.i.

We offer your designers the full collaboration of our engineers.

LEY'S MALLEABLE CASTINGS CO. LTD., DERBY. TELEPHONE: DERBY 45671

STRENGTH & RIGIDITY

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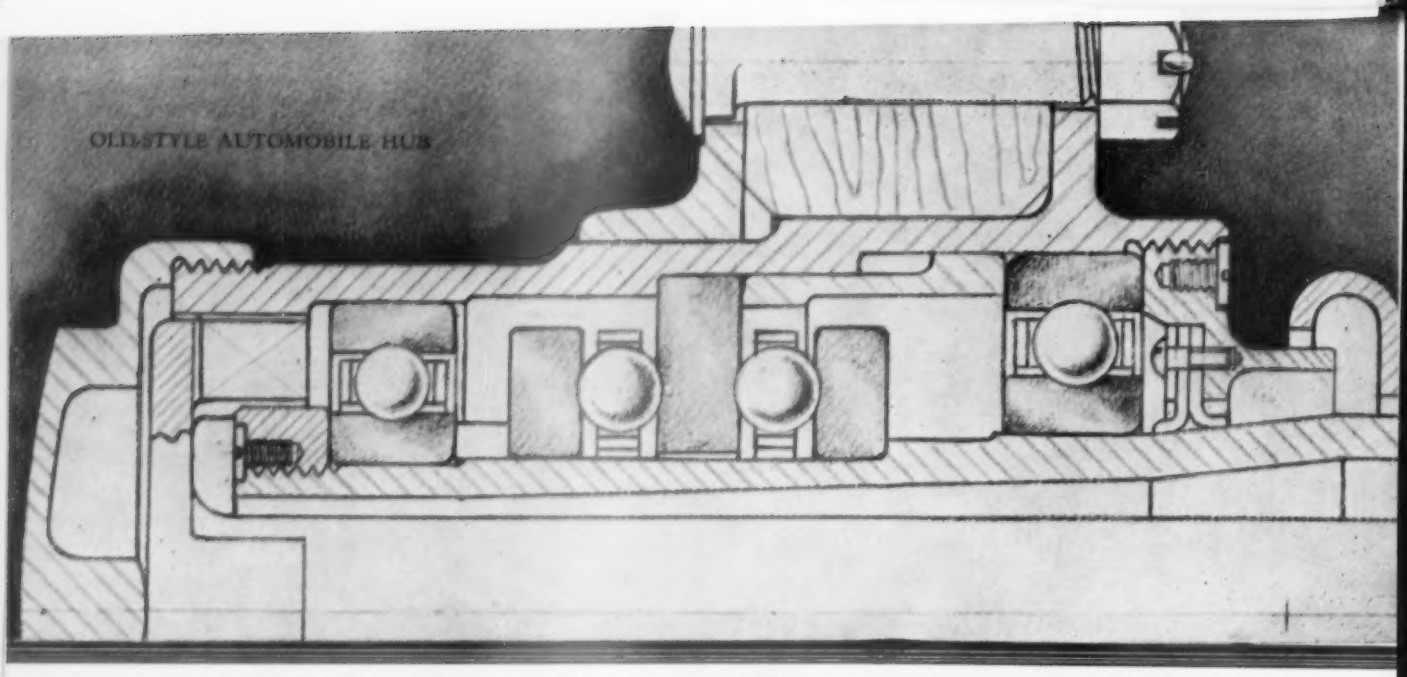

. . . them days has went!

IT is astounding that many designers, looking ahead in many other respects, think in terms of ball-bearings dating back to the hobble-skirt period — eminently suitable for the suburban lawn mower but having nothing up their sleeves in the way of refinement or potentialities for pepped-up performance.

Things have altered; nearly every new design of machine has a higher performance than its predecessor, yet before a couple of years have passed, it is being given a higher load, or a greater speed or some other extra duty, *and the bearings are expected to 'take it'.*

There they are, often pinched a bit to begin with, generally buried away in a densely built-up area where it's a major operation to alter anything; their diameters may be limited by the shaft centres, and from a state of being forgotten as taken-for-granted components they suddenly become urgent matters of the moment.

We at F.B.C. have—in the best circles—a very high reputation for helping out on this problem and we are constantly evolving bearings for meeting high loads, high speeds and other conditions with outstanding success in aircraft, machine tools and many other branches of engineering.

DESIGNERS who put their dusty ball-bearing catalogues to one side and turn to us for consultation will find that our engineers are full of high-performance experience.

F.B.C. :: FISCHER

FBC

TRADE MARK

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BALL AND PARALLEL-ROLLER BEARINGS

FISCHER BEARINGS COMPANY LIMITED, WOLVERHAMPTON

FISCHER BEARINGS COMPANY LTD. and TIMKEN-FISCHER STOCKISTS LTD., BIRMINGHAM

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★ Extreme lightness.
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★ Non-inflammable qualities available.
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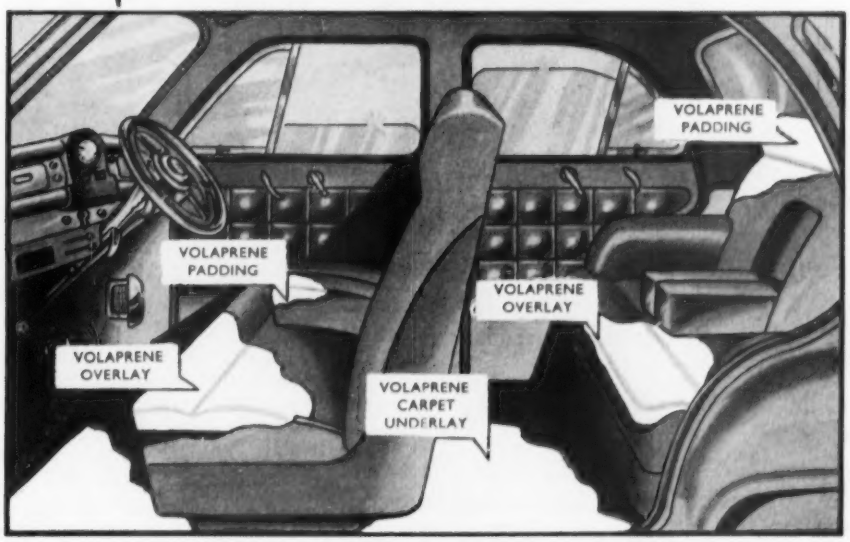

Manufactured in BRITAIN by **Volcrepe LTD**

GLOSSOP, Derbyshire

from whom samples, prices and full details can be obtained

When

weight

is a

problem

Come to think of it, weight nearly always *is* a problem.

In almost every branch of industry—and particularly in transport—weight saved means greater all-round efficiency and economy.

That's where light, strong and durable 'Kynal' wrought aluminium alloys come in—enabling weight to be reduced without loss of strength. With the aid of the Technical Service and Development staff of I.C.I. Metals Division, engineers and designers are constantly finding new uses for 'Kynal' alloys.

May we help solve *your* weighty problems?

'KYNAL' AND 'KYNALCORE' wrought aluminium alloys are already extensively used in the following industries:

Aircraft : *ribs, spars, engine components, stressed skin covering, fittings, etc.*

Railways : *structural members, roofing, panelling, windows, luggage racks, etc.*

Road Transport : *structural members, floor planks ana panelling, windows, tread strips, doors, small fittings, etc.*

Shipbuilding : *bridges, wheelhouses, outer funnels, lifeboats and davits, decks, skylights, stanchions, bulkheads, watertight doors, etc.*

Building : *roof coverings, side claddings, ventilators and windows, panelling, interior fittings, etc.*

'KYNAL' AND 'KYNALCORE' WROUGHT ALUMINIUM ALLOYS

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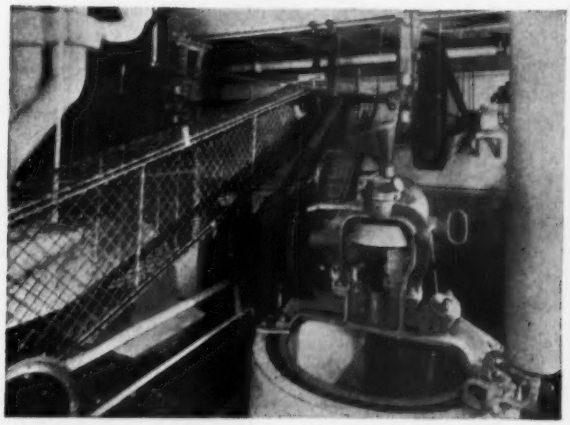
IMPERIAL CHEMICAL INDUSTRIES LIMITED, LONDON, S.W.1

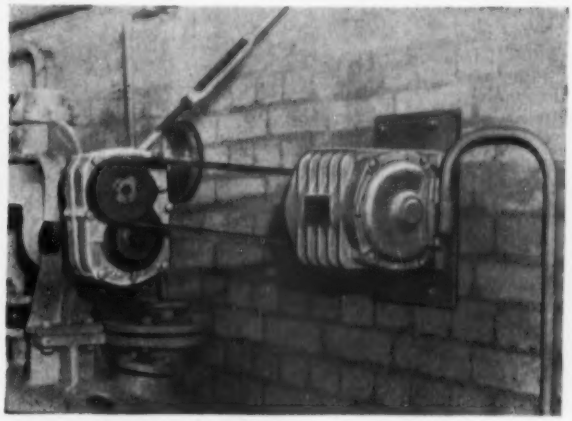
M138

NOW! SPACE IS NO PROBLEM IN SPEED REDUCTION



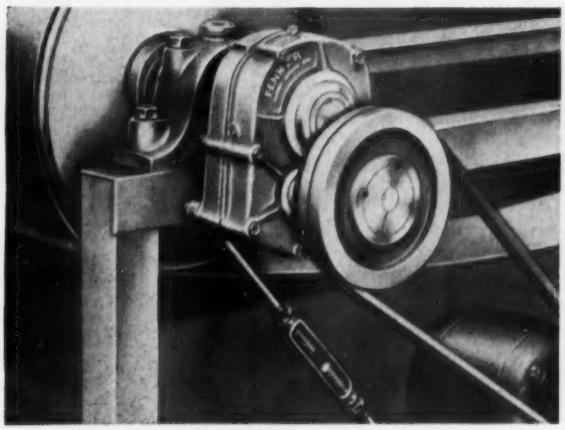
THE OLD METHOD.

A nationally famous firm of manufacturing chemists had the problem of driving chemical mixers at 60 r.p.m. A base mounted gear box was impractical and a cumbersome and expensive double reduction overhead drive had to be used.



THE NEW METHOD.

A Torque-Arm shaft mounted speed reducer was installed on top of the mixer driven through a Taper-Lock V-Drive by a wall mounted motor. Advantages: clean safer drive, economy in space, simplified maintenance, more useful power transmitted.



TORQUE-ARM CAN HELP YOU TOO!—

Space limitations no longer prevent you installing a speed reducer. The Fenner Torque-Arm Reducer mounts direct on the driven shaft and can be driven through any V-Belt Drive. It delivers up to 97% of power to output shaft. No motor base or slide rails are required, no flexible couplings needed. It is suitable for the majority of slow speed drives.

TECHNICAL LITERATURE IS AVAILABLE.

Literature giving all the facts about Fenner Torque-Arm Speed Reducers is available . . . send for your copy TODAY. Fenner Technical Advisory Service will be glad to consider your Speed Reduction problems and advise on the suitable application of Torque-Arm Speed Reducers.

J. H. FENNER & CO. LTD. · HULL · ENGLAND

See Torque-Arm demonstrated at the B.I.F. Castle Bromwich — May 2nd to 13th. FENNER STAND D406.

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FIRST WITH TORQUE-ARM SHAFT SHAFT MOUNTED *MOUNTED SPEED REDUCERS IN THE U.K.*

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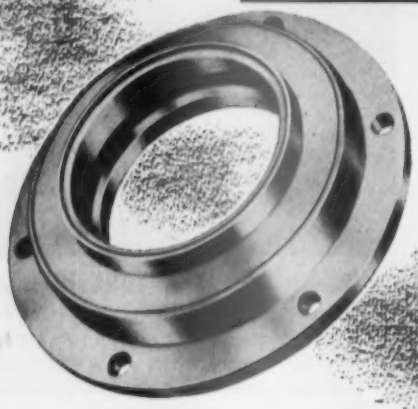
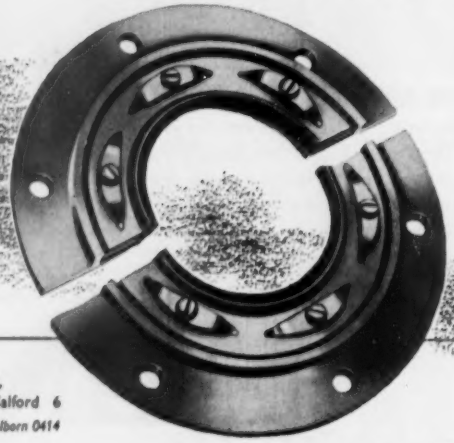
OIL SEALS

Weston Oil Seals and 'O' Rings protect and enhance the performance of almost every kind of mechanical equipment and under almost every condition throughout the world. They are vital parts of equipment which have to retain lubricants and keep dirt and water out. 21 years' experience is at your disposal.





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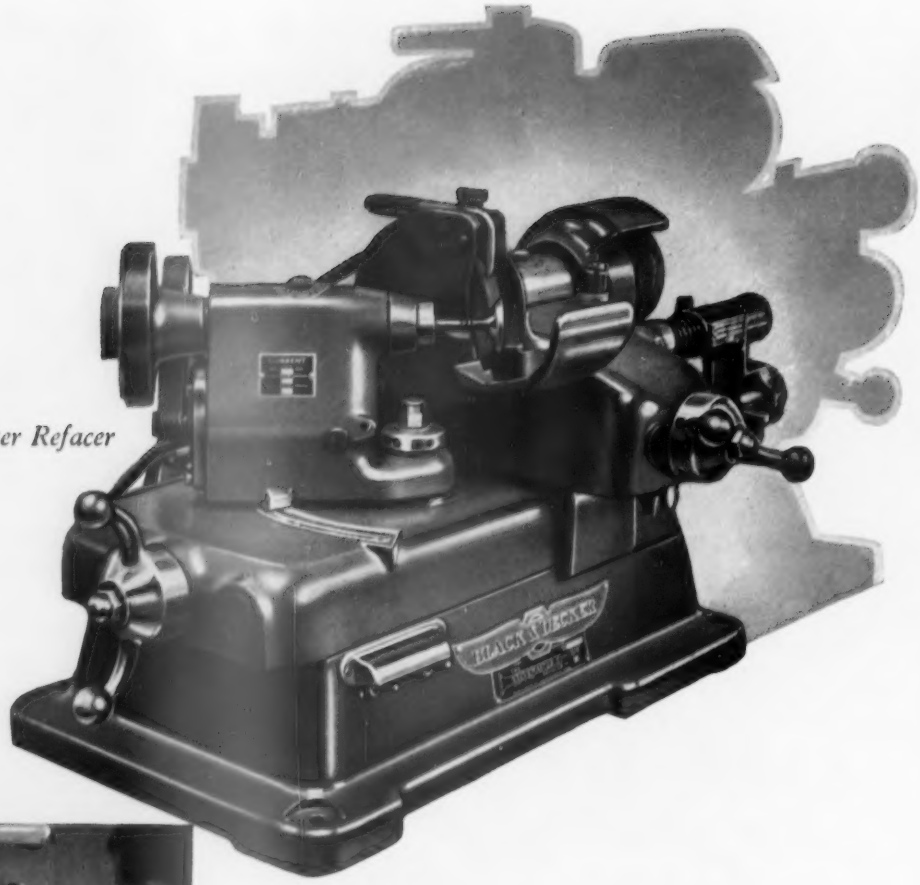

Valve Master Refacer

***The B&D Valve Shop** incorporates the Valve Master Refacer, the Vibro-Centric kit and the Carbon Removing kit in a transportable cabinet.* ***The 55° Vibro-Centric** Valve Seat Grinder used for working in confined spaces.*

OF COURSE YOU KNOW...

. . . that badly matched or pitted valves destroy the smooth running of an engine . . . reduce power . . . increase petrol consumption—but DO YOU KNOW that the quickest, easiest and best way of righting all valve faults is with B&D equipment. The Valve Master Refacer refaces a set of valves to any angle with mirror-smooth finish in a matter of minutes and with an attachment grinds tappets, rocker arms and Ford Valve Stems! Its sister tool the 'Vibro Centric' valve seat grinder ensures a perfect match between valve and seat every time!

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PORTABLE ELECTRIC TOOLS

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FOR ALL INDUSTRIES

To their world-renowned range of MORRISFLEX Flexible Shaft and Polishing Shop equipment, B. O. Morris Limited of Coventry have now added:—

SEMI- AND/OR FULLY- AUTOMATIC POLISHING, BUFFING, BRUSHING AND FETTLING MACHINES

designed specifically for individual operations to the special requirements of every branch of industry and in particular that engaged in the manufacture of Motor Car Accessories.

These Special Purpose Machines possess three very important advantages:—

1. **A CONTROLLED AND THEREFORE CONSTANT FINISH**
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3. **A SOLUTION TO THE PROBLEM OF LABOUR SHORTAGE**

B. O. Morris Limited, will be pleased to place their unrivalled polishing and finishing technique together with their specialised engineering experience and resources at your disposal.

Morrisflex

B. O. MORRIS LTD., MORRISFLEX WORKS, BRITON ROAD, COVENTRY
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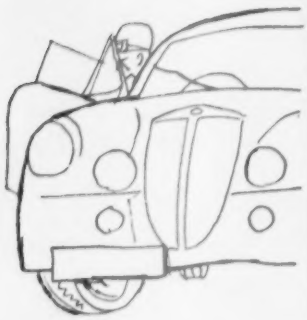
Ferodo make doubly

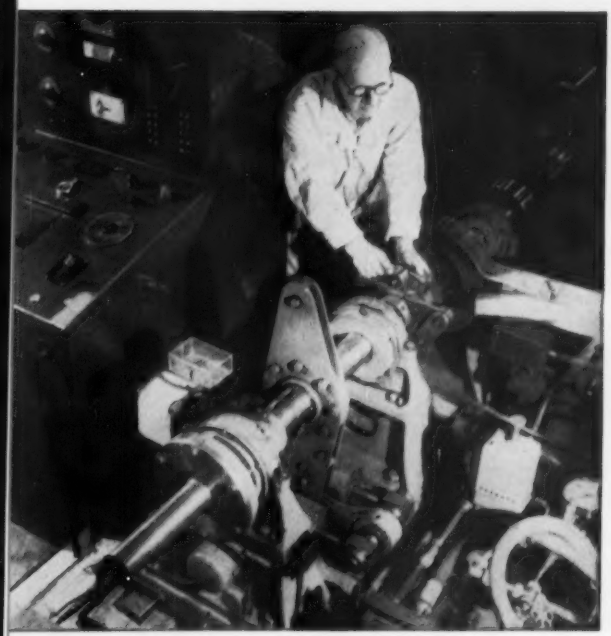


Heavy transport lorries, light delivery vans, racing cars and family cars—all kinds of vehicles, all over the world rely on Ferodo Anti-Fade Brake Linings . . . quite a responsibility! So Ferodo make doubly sure of quality . . . doubly sure of safety . . . by methodical testing and precision manufacture.

TESTING takes place throughout the production of Ferodo Anti-FadeBrake Linings, from investigation of basic materials to inspection of finished products. The laboratory, the uniquely equipped Test House, the powerful cars of the Ferodo Test Fleet, all are constantly at work, making the efficiency and safety of Ferodo Linings a calculated certainty.

FERODO FACILITIES FOR RESEARCH AND TESTING ARE FREELY AVAILABLE TO THE MOTOR INDUSTRY AT ALL TIMES

sure



In the MANUFACTURE of Ferodo Linings, the emphasis is on precision. Whether it's a hydraulic press forming liners to their finished radius, or a giant multiple drill, every machine is itself the result of research and experience. This fact, combined with strict examination at every production stage, ensures that on any make of car in the world, the correct Ferodo Lining will always fit perfectly.

FERODO **ANTI-FADE Brake Linings**

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COMMERCIAL VEHICLE GEARBOX
Weight, 68 lbs.
By courtesy of E.N.V. Engineering Co. Ltd., and Dodge Bros. (Britain) Ltd.
DARTMOUTH AUTO CASTINGS LIMITED
SMETHWICK 40 BIRMINGHAM
Specialists in high duty iron castings for the Motor Industry

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LUBRICATION

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Besides producing colloidal graphite in all the numerous forms adapted to its hundreds of present industrial applications, the Acheson organisation now applies its unique experience and facilities to preparing many other colloidal dispersions in various media. Among these, today's news item is . . .

COLLOIDAL MOLYBDENUM DISULPHIDE

An outstanding, new industrial lubricant, particularly for use at high pressures and speeds.

In your own work there is certainly more than one point at which 'dag' Colloidal MoS_2 could help — may we send you the latest technical information?

Write today for full particulars of this important development to:—

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Colloidal Dispersions of Graphite, Molybdenum disulphide, Silver and other solids, in oil, water and volatile solvents for every industrial requirement. Please write for literature.

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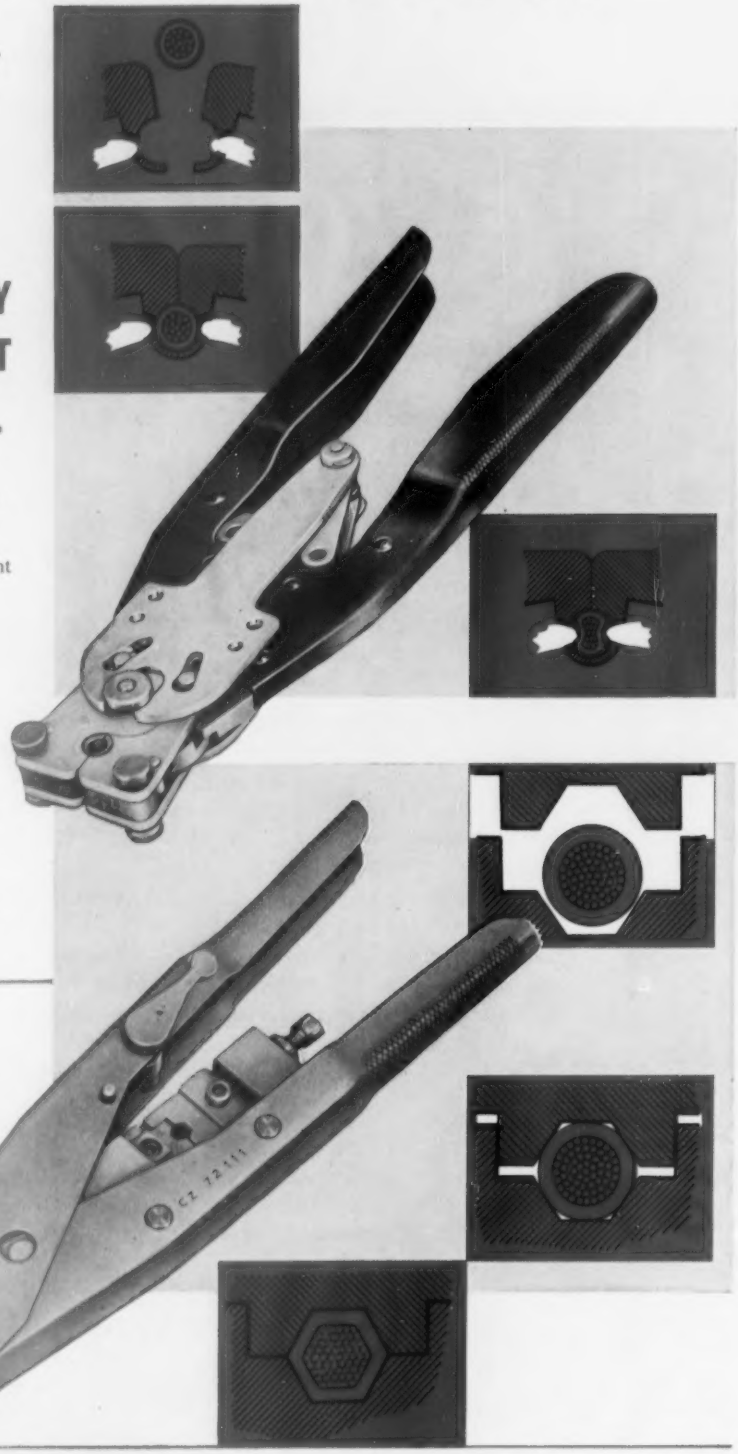
SOLDERLESS CONNECTIONS

Faster and better by

Plessey

LIGHT & HEAVY DUTY CRIMPING EQUIPMENT



No other electrical tag-to-lead connection is so quickly accomplished, so long lasting, so thoroughly reliable as that which is made by a Plessey crimping tool. These precision crimping tools range from a hand-operated light duty type, through to a heavy duty hydraulically-operated unit.

Originally pioneered and developed for the aircraft industry to overcome the disadvantages of corrosion, crystallisation and other accelerated deterioration factors in any method employing heat and flux—this solderless crimping method achieves a wiring connection which is both mechanically and electrically superior for a fraction of the cost.

For its success, any crimping process relies wholly upon the accuracy of the equipment used. Consistent with such standards these advanced tools are produced to fine engineering limits from the finest materials.

Plessey publication 753/1 contains extensive details of these tools and their application. A copy will be sent to Manufacturing and Government Department executives and to design engineers free, on request.

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Better light...
FOR BETTER WORK

Down a little!

Still nearer!

Right on the job!

However skilled a worker may be, he must 'see' the job. This applies especially in lathework, valve-grinding, on milling machines or power drills, etc., wherever adjustable close-to-the-job lighting is a sheer necessity.

ANGLEPOISE throws a clear shadowless light right on the work, not in the user's eyes and follows the job from any angle at a finger touch, degree by degree. It 'stays put' in any required position in the presence of heavily vibrating machinery and needs only a low power bulb for high class results. If you would like to know more about these fine lamps write for Booklet A.

THIS IS HOW ANGLEPOISE LIGHTS UP THE JOB IN STRONG RELIEF— SAVING EYESTRAIN AND FATIGUE

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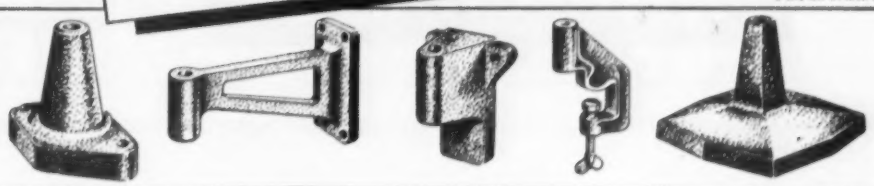
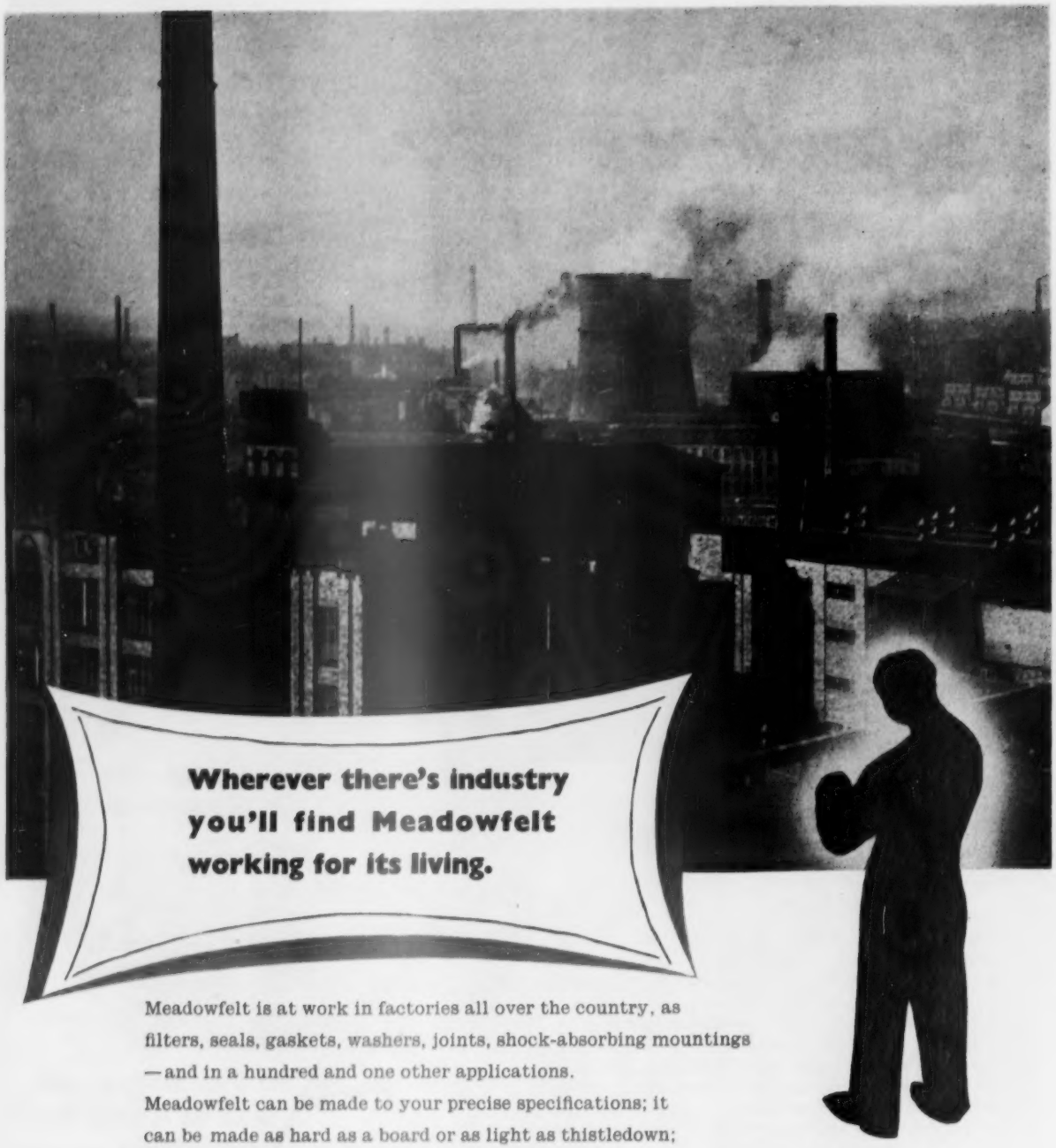
SOME ALTERNATIVE BASES FOR ALL MODELS



MTH



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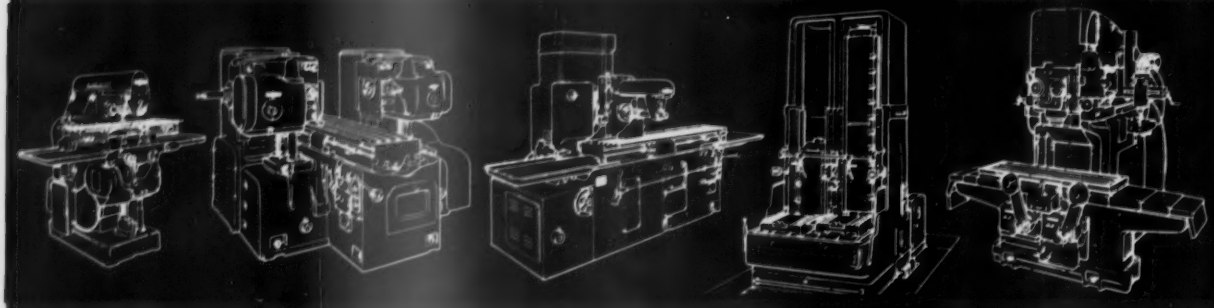

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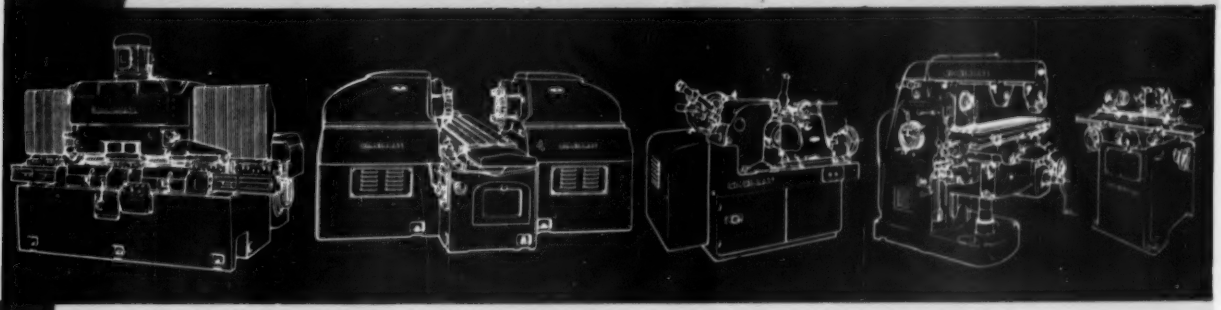

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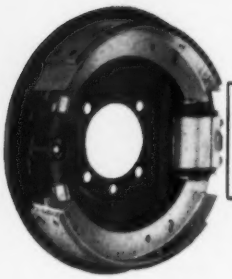
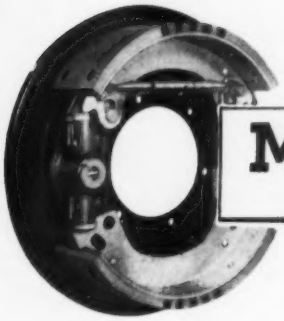
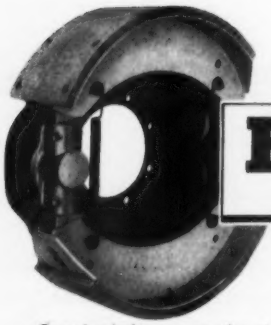


LIGHT
duty



MEDIUM
duty



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Soon pays for itself!

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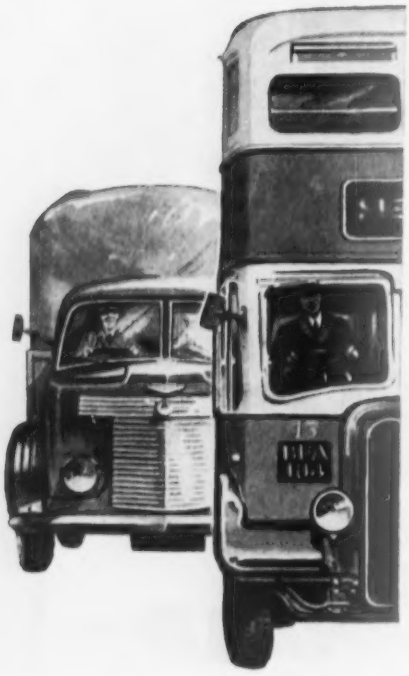

The ' Syndromic ' system lubricates up to 80 bearings (using 2 pumps)—at periods automatically controlled by mileage—*while your vehicles are on the road !* In this way, hold-ups for lubrication are eliminated and you get as much as 10% more service out of your fleet at no extra cost. In fact, ' Syndromic ' automatic lubricators are *more* economical. They save 75% on lubrication, reduce wear on bearings, etc., and therefore cut maintenance and replacement costs to a minimum.

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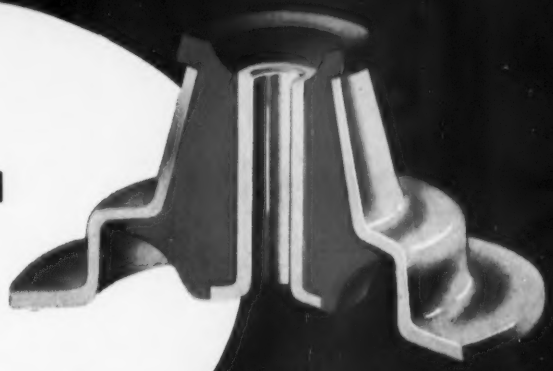
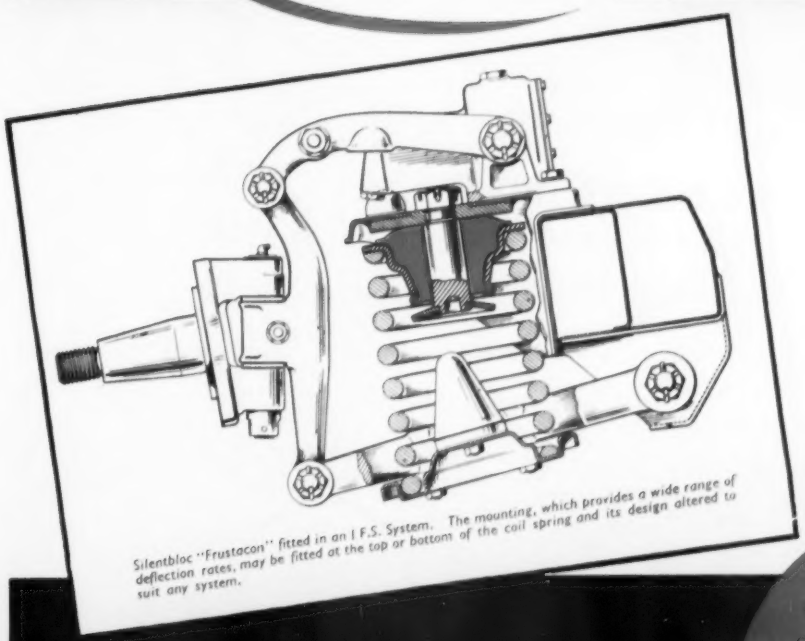
. . . the first scientifically designed flexible mounting fitted to the I.F.S. of a Production Car



The 'Frustacon' mounting fitted to the I.F.S. of the 1952 Rover '75'. Sectioned to show rubber.



Silentbloc "Frustacon" fitted in an I.F.S. System. The mounting, which provides a wide range of deflection rates, may be fitted at the top or bottom of the coil spring and its design altered to suit any system.

To minimise the transmission of road noise to the body by the coil springs, Silentbloc Frustacon mountings have been incorporated in the I.F.S. of the 1952 Rover '75'. This notable step forward in the reduction of noise is another example of co-operation between car manufacturers and Silentbloc Ltd.

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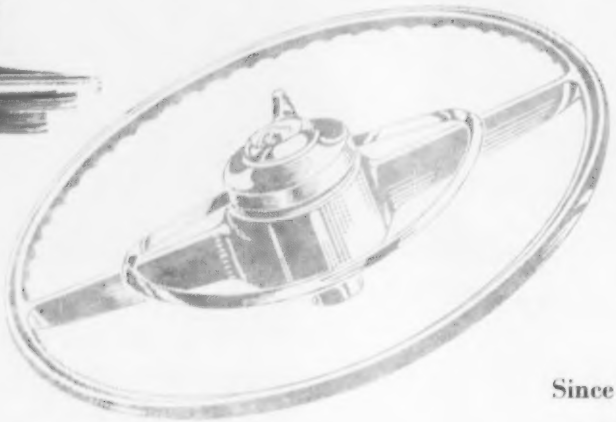

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Trafficators 1955

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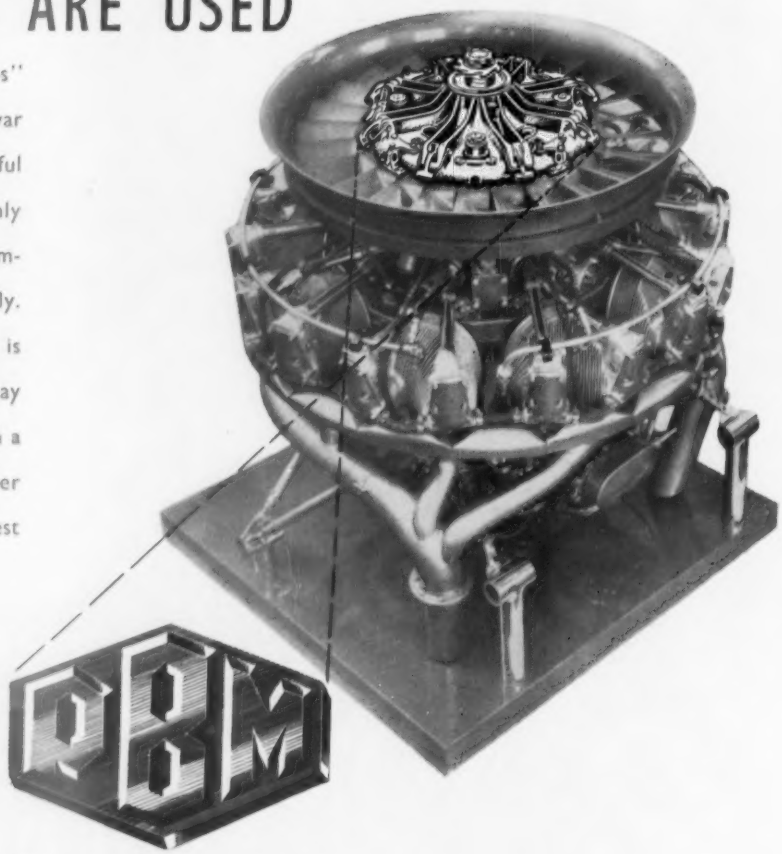

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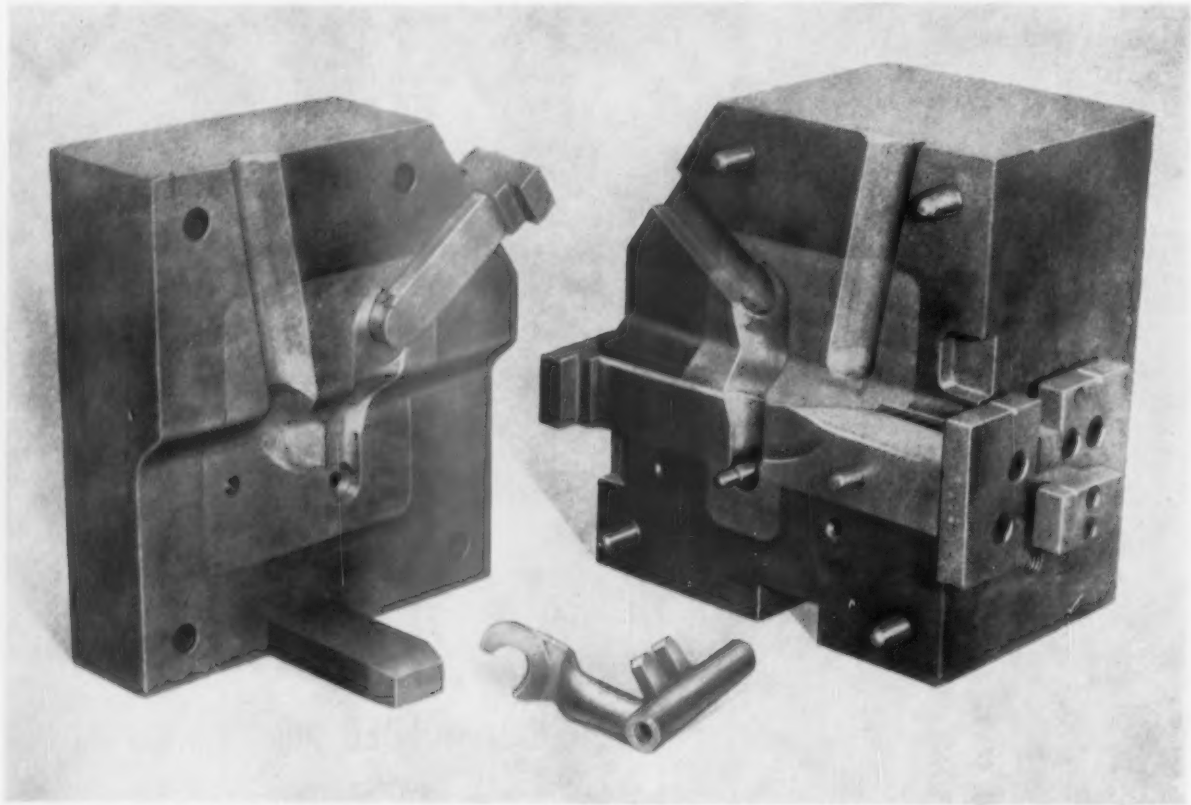

Dies with inserts of Nimonic 80 have become standard for aluminium-bronze gravity die-casting. *(By courtesy of Sagar Richards Ltd.)*

Moulds for gravity die-casting are continually exposed to intense heat and to thermal shock. When casting aluminium-bronze, for instance, the pouring temperature is in the region of 1,150° C. For the dies to retain their accuracy, the die material must resist damage from scaling and oxidation and, to be economically justified, it must give long service. Messrs. Sagar Richards Ltd. of Luddendenfoot, near Halifax, who produce a wide range of aluminium-bronze die-castings, mainly for the automobile industry, have, for several years, used Nimonic alloys for die inserts and cores. Nimonic 75 and Nimonic 80 have extended die life so considerably that their use is now practically standard.

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GP/44

Ford Motor Company Limited uses

The photograph shows the actual instrument used by Ford Motor Company Limited at the Motor Industry Research Association's proving ground, Nuneaton. It successfully recorded data while going round the track at 90 m.p.h.

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for rugged road tests

The Brown Multi-Point Strip Chart Recorder is being used by the Test Department of Ford Motor Company Limited to measure and record various temperatures of vehicles under road tests.

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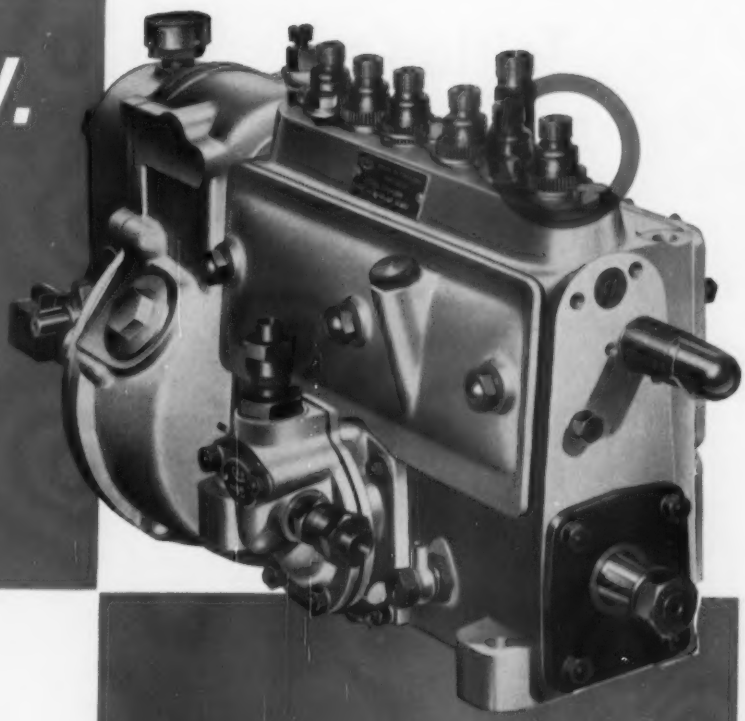
F.35

The C.A.V. 'N' Type Fuel Injection Pump



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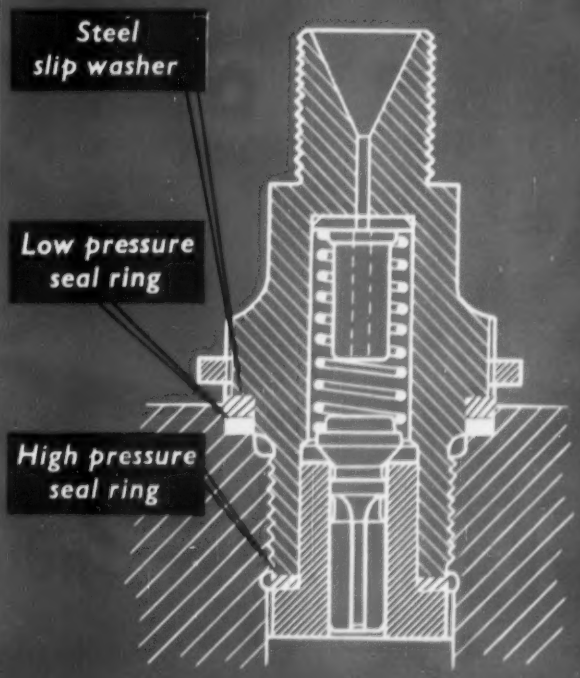

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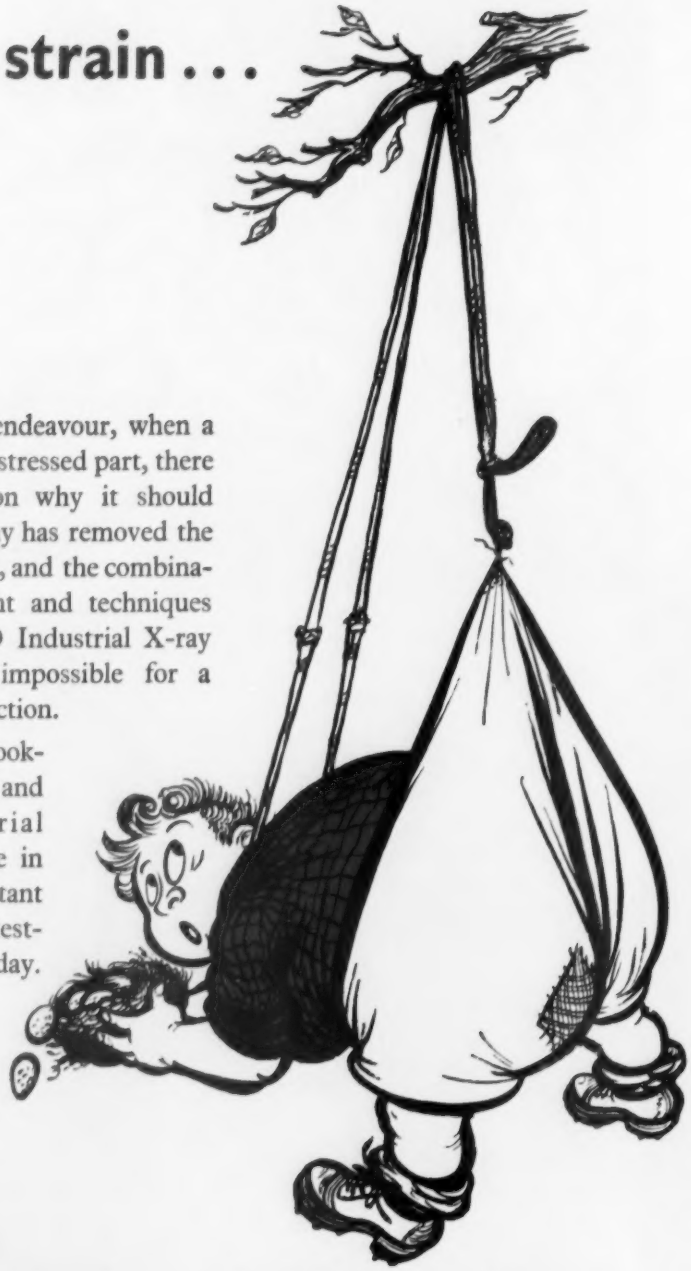

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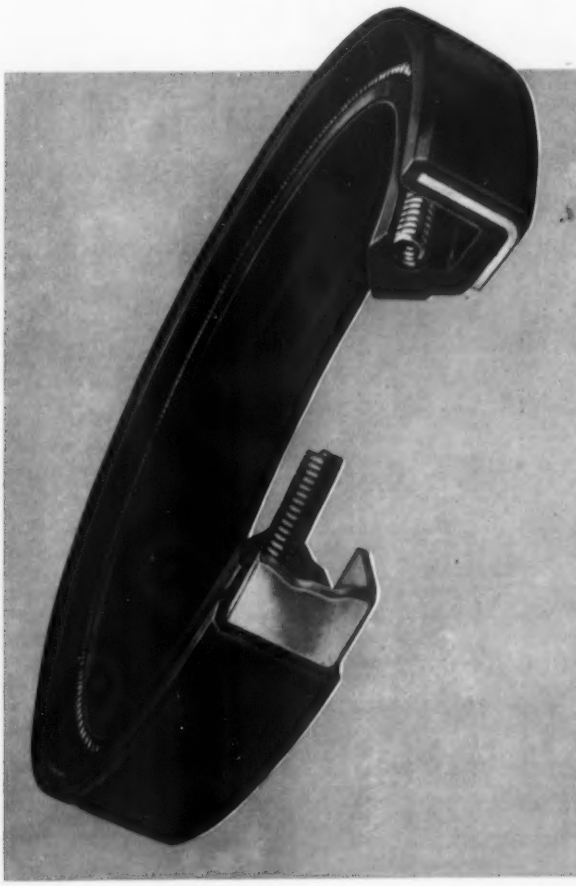

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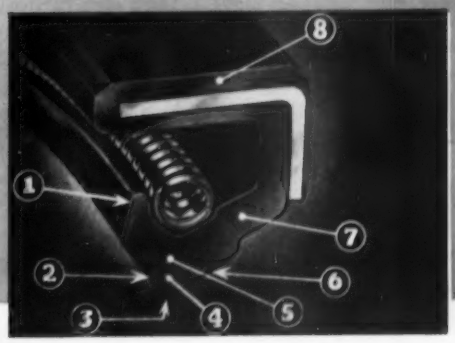

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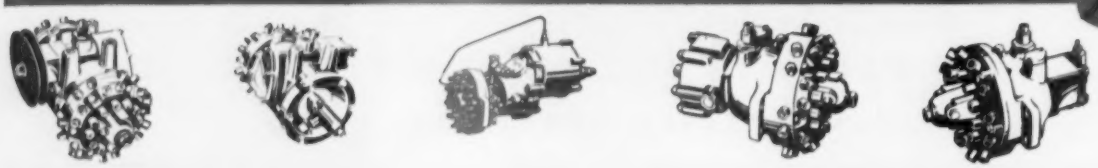
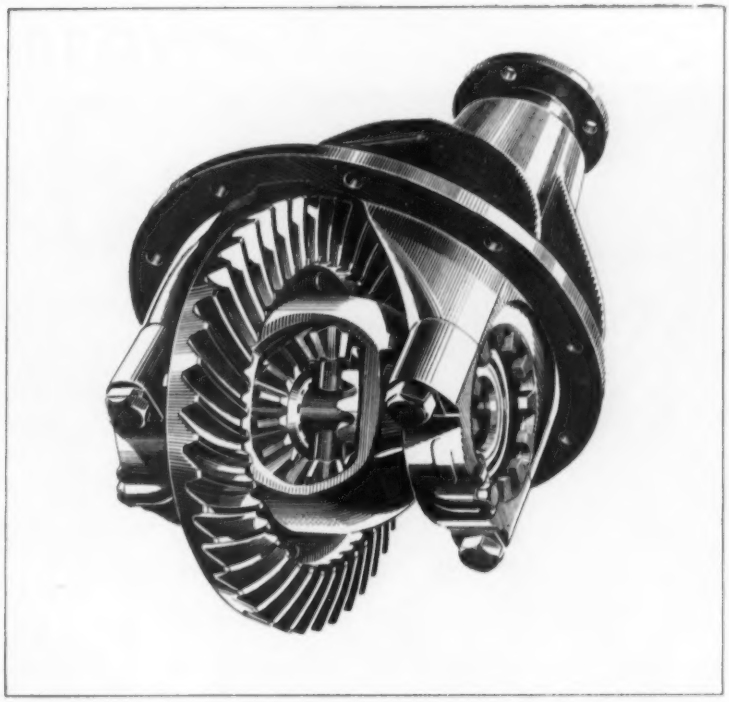


L.20



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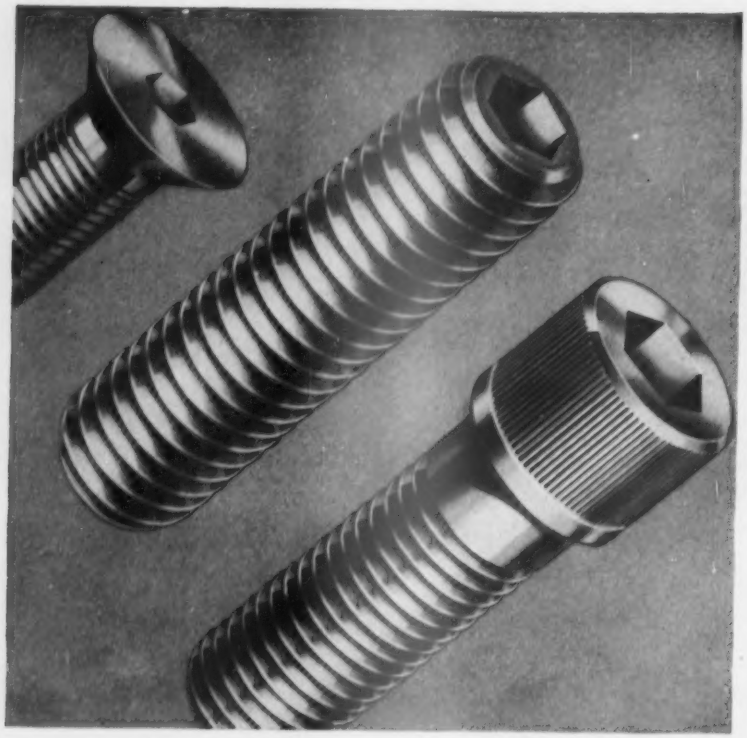

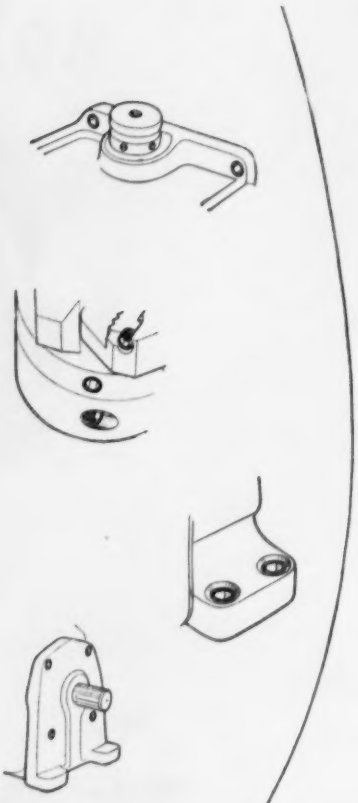

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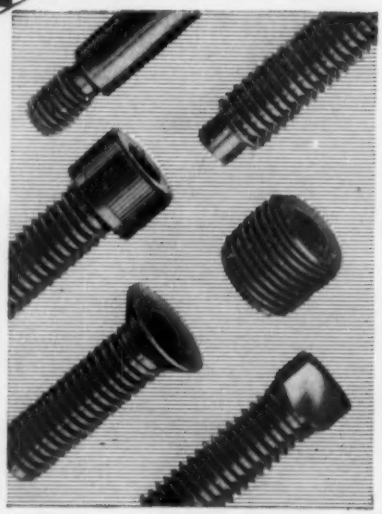

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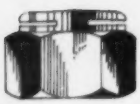

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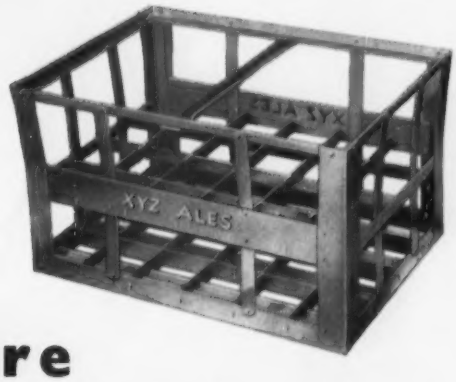

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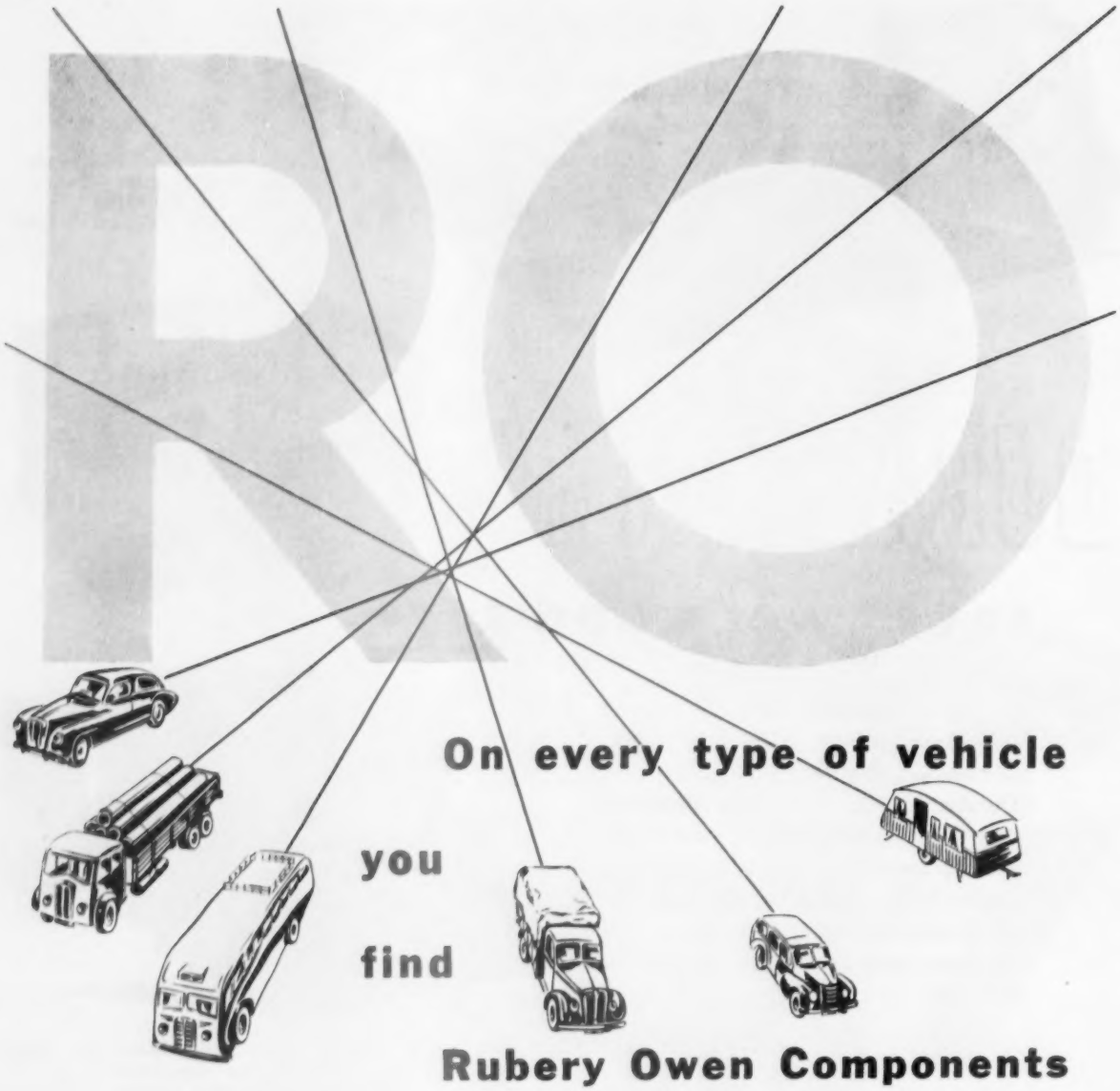

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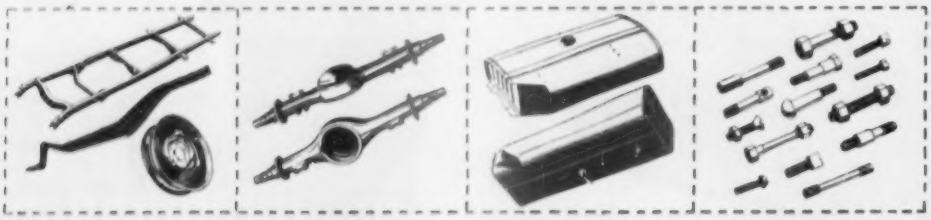

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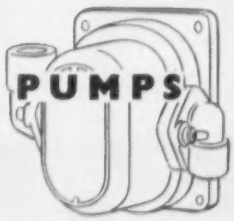

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AUTOMOBILE ENGINEER

Design, Materials, Production Methods, and Works Equipment

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Petrol Tanks

THE task of designers who have to cater for a wide range of exports is not easy. They must study and attend to a multitude of detail features, so that customers throughout the world shall not have cause to complain of petty shortcomings which, under operating conditions peculiar to their individual localities, may be inconvenient or even lead to minor failures of components. One trouble that is liable to occur in certain circumstances is vapour lock. This has been discussed fully in a recent paper of the Automobile Division of the Institution of Mechanical Engineers, and an extract of the paper is published in this issue of *Automobile Engineer*.

One of the suggestions made in the paper is that the suction head between the tank and the fuel pump should be as small as posssible. There has been a tendency, so far as tank position is concerned, to lag behind other parallel developments. When nearly all private cars had separate frames, there was a good case for mounting the petrol tank on the frame, rather than on the body Moreover, in cars with enclosed luggage boots at the rear and the engine at the front, the only space available for the tank was under the boot floor. Before the last war, this layout was reasonably satisfactory, since British manufacturers did not cater primarily for export markets, and conditions leading to vapour lock occur only relatively infrequently in this country.

Even after the adoption of chassisless construction became widespread, the underfloor tank arrangement persisted. Then manufacturers began to realize that, by employing tanks of a different shape to fit in spaces, such as behind the wheelarches, that could not be used readily for any other purpose, they could make available a useful amount of extra room in the boot. It now seems that this development might be carried a stage further by installing the tanks as high as possible. This measure would help slightly to offset any tendency to vapour lock.

In some instances, considerable improvement could be effected by installing the tank in a position well clear of the exhaust pipe. Not only are the effects of radiation from the pipe detrimental, but also it has been known for the airflow over the vehicle to sweep the exhaust gases from the end of the pipe round the tank and to raise appreciably the temperature of the petrol. However, in deciding on the best position for the tank, it is also necessary to consider the effects of exposure to the hot sun. Ventilation of the boot to keep it cool while the vehicle is stationary presents almost insurmountable problems, since it would tend to negate all attempts at sealing against the ingress of dust.

So far as the avoidance of vapour lock is concerned, there seems to be no reason why adequate ventilation should not be afforded by an opening in a high position on the bonnet so that, when the vehicle is stationary, air can circulate and cool the engine compartment, and therefore the fuel pump, pipelines and carburettor. A forward facing vent is not necessary, and may not even be desirable, since in some instances it has been known to lead to carburettor icing troubles in cold weather. There is much to be said for a vent at the trailing edge of the bonnet; this has the additional advantage that it tends to direct warm air over the windscreen and helps to solve screen de-icing problems.

Geneva Show

NO matter how few new models are introduced at a motor show, an automobile engineer can always find plenty to interest him there; in fact, he invariably has not enough time to study the exhibits in sufficient detail. Thus, although there were few new models at Geneva, there were, nevertheless, many lessons to be learned. Among the coachbuilders' exhibits, the Pinin Farina body on a Fiat 600 chassis attracted much attention because of its unconventional rear light. This arrangement has so much to commend it that it is worthy of careful consideration. Its advantages and disadvantages are discussed fully elsewhere in this issue of *Automobile Engineer*.

The latest American exhibits are less ornately decorated than they have been of recent years. In the United States, bumpers generally are regarded as an essential first line of defence and, in tightly packed car parks, are even used to clear sufficient space to enable vehicles to be extricated. In any case, large cars require big bumpers, so these components are unlikely to be reduced to a size comparable with that of European designs. Nevertheless, a number of American manufacturers currently are using much less chromium plate on the front ends of their cars than hitherto. This reduction has been effected mainly by lightening the components of the grille.

Wrap-round windscreens are becoming increasingly popular. Where they are applied to improve the forward range of vision they are a good feature, but in some instances the side pillars are in almost the same position,

relative to the driver, as would be those of a conventional screen. This pandering to fashion is hardly likely to deceive customers for long, and it is to be deplored because there are marked disadvantages to the wrap-round screen arrangement. These disadvantages include increased cost, complication of the demisting problem and the difficulty of designing windscreen wipers to sweep a useful proportion of the wrap-round area. Moreover, the door pillar shape is awkward, and is not sound structurally.

The production car that aroused the most interest at the Show was the Fiat 600. This model undoubtedly will be popular in Italy, since one of the most noteworthy features of the vehicle is its low fuel consumption, and in that country petrol costs about 7s 3d a gallon. However, it does not necessarily follow that the car would be equally popular in this country nor that the demand here would be great enough to warrant the production of a vehicle of this type by British manufacturers.

Front or Rear Engine

DOUBTLESS, with the advent of yet another rear-engined car—the 633 cm³ Fiat—the subject of engine position will once again be widely debated. The fundamental principles involved are, however, by now reasonably clear. Many manufacturers of high repute are producing cars with the rear-engine and rear-wheel drive arrangement or of the front-engine and front-wheel drive layout. This tends to show that these layouts, contrary to opinions expressed by those who have not ventured to adopt them in practice, are more economical to produce than the conventional installation.

There can be only one reason why the greatest economy is obtained by grouping the engine and transmission at one end or the other. It is that, despite the fact that two additional sliding and universal joints are needed, the extra cost of these is more than offset by the savings obtained by combining the gearbox and final drive in one casing, the elimination of the propeller shaft and its tunnel, and by the reduction obtainable in the overall size of the vehicle. Undoubtedly, if economy in manufacturing cost is the prime requirement, one of these two arrangements should be adopted.

However, they are not without their disadvantages. Rear-engined vehicles tend to be more noisy than conventional types. Nevertheless, there seems to be no reason to believe that this is necessarily so. Possibly, the noise in most instances is more easily transmitted through the relatively large flat panel that comprises the rear bulkhead, whereas the transmissivity of the front bulkhead is less because it is divided into small areas and stiffened by the relatively large wheelarches, tunnel, dash and scuttle and, in some chassisless designs, by one or more main cross members. This seems to indicate that more attention to the stiffening and insulation of the panel at the rear might solve the noise problem.

Front-wheel drive

The front-wheel drive arrangement, because of the need to steer the driven wheels, may tend to be slightly more expensive than the rear-engine layout; also, the mechanical components are more vulnerable to damage in the event of an accident. Moreover, if the power unit is of the in-line type, the bonnet tends to be unduly long and the front overhang excessive. If the front-engine and front-wheel drive system had marked practical advantages, the public doubtless would accept it. In fact, it probably has advantages for the skilful driver, but the different handling characteristics as between the over-run and drive conditions are so marked that possibly more skill is needed to drive cars of this type than of most others.

Rear engines

Widely differing opinions have been expressed about the handling characteristics of rear-engined cars. This is because with the preponderance of weight on the rear, the traction obtainable, particularly on ice, is better than that of most other types of vehicle. For the same reason, break-away tends to be delayed. Accordingly, the type of driver who never pushes his car to the limit of its performance finds that rear-engined vehicles generally are easier to drive than those of any other layout. However, once the rear end does break away, it is extremely difficult, and in many circumstances impossible, to regain control. Therefore, this layout would appear to be suitable only for vehicles of relatively low performance. Of course, there are exceptions to this generalization.

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THE FIAT 600

First Impressions, with Special Reference to the Bodywork, of a Design that is Noteworthy for Economical Use of Space

FIAT have recently introduced their new 600 model to replace the Fiat 500, which was first put into production in 1936. The earlier model was well known in this country as well as in Italy, where it was spontaneously dubbed *Topolino* (Micky Mouse) by the public. In the new vehicle, accommodation is provided for four people instead of two, as in the earlier model. It is now generally regarded as essential to provide four seats in a car to be produced in large quantities, otherwise the demand is not great enough to absorb an output of sufficient magnitude to maintain the price at the low level that is one of the essential attractions of a small car.

Despite the fact that the 600 model accommodates four passengers instead of two, it is 5 in shorter and 1½ in lower than the earlier model. However, it is 3½ in wider, so there is ample elbow room for the passengers. The weight of the new four-seater is 11 lb less than the earlier two-seater. This reduction in weight has been effected without any sacrifice in stiffness or strength, and it has been made possible by modern developments such as more advanced knowledge of integral construction technique and improved suspension layouts.

Like many of the very small cars produced on the Continent, the new Fiat has the engine at the rear. This arrangement has been adopted, in preference to the front engine and rear wheel drive layout, because it allows the greatest possible amount of passenger space to be obtained within a given overall length. A further gain in length of passenger and interior luggage space has been obtained by positioning the radiator beside the engine instead of between the cylinder block and the rear seat squab. To do this it has been necessary to use as small a radiator as possible. Accordingly, a high efficiency, multi-blade, ducted fan is employed.

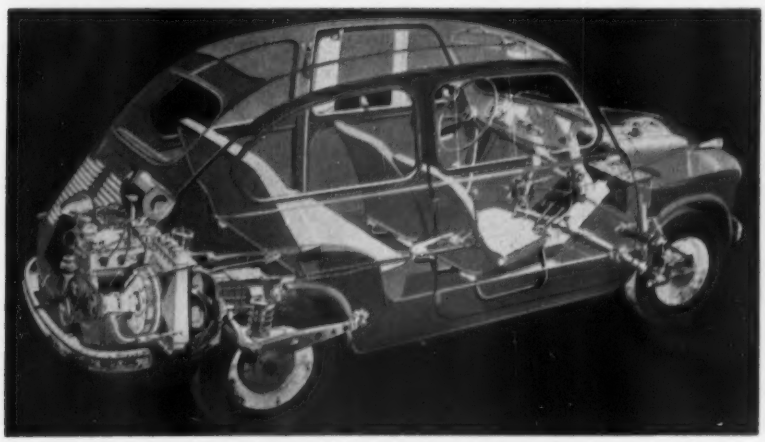
The new Fiat 600 is a two-door vehicle with seats for four passengers, and the engine is at the rear

Another advantage of the rear engine arrangement is that it obviates the need for a relatively large tunnel to accommodate the propeller shaft in the bump position. A small tunnel has, in fact, been incorporated in this car to form one of the main longitudinal members of the structure. It also is convenient in that it houses the engine and gear shift controls, which otherwise would have to be accommodated under the floor. In the underfloor position they would be exposed to the dirt splashed up from the front wheels and also would be liable to suffer damage if the vehicle were driven over rough terrain.

Some saving in weight is obtained by combining the final drive and gearbox in one casing. There is also the possibility of obtaining better ride characteristics, because independent suspension is employed all round. Nevertheless, the swinging half shaft arrangement, with independent rear suspension, is generally regarded as inevitably more expensive than the conventional through axle.

There are two main disadvantages associated with the rear engine layout. One is that luggage space is restricted, and the other is that it is difficult to obtain a satisfactory weight distribution. To improve the weight distribution, the spare wheel is housed vertically in a transverse plane at the extreme front end. The battery also is carried at the front, in a well immediately behind the spare wheel, and the 6 gallon petrol tank is mounted on the dash. This has given a front : rear weight distribution of 43 : 57 with two people in the front seats. Because of the relatively high position of the tank and the fact that it is not liable to be subjected to heat radiation from either the engine or the exhaust system, there should be no trouble with vapour lock in this car.

Although the luggage space beside the tank is small, its dimensions are 12 in deep × 18 in long × 22 in mean width, additional luggage can be accommodated behind the rear seat squab. Even so, since the distance between the squab and the rear bulkhead at the top is only 7 in and at the bottom 10 in, there is not enough room for four passengers as well as their luggage for a holiday. If only two passengers are accommodated, however, there is ample luggage space, because the rear seat



The general layout of the Fiat 600 shows how space has been used to the best possible advantage in the design

Although the spare wheel is at the front, it does not impede access to the luggage space

To reduce the overall length of the power unit installation, the radiator is mounted on one side

squab can be hinged down on to the seat cushion to form a large flat platform. Unlike the Citroen 2CV, this vehicle has a conventional saloon roof, so almost any luggage rack could be fitted on it without difficulty.

Specification

The principal dimensions are as follows: overall length 10 ft 6½ in, width 4 ft 6⅜ in, height fully laden 4 ft 4¾ in. A wheelbase of 6 ft 6¾ in has been adopted and the track dimensions are: front 3 ft 9 in and rear 3 ft 8⅜ in. Underneath, the ground clearance is 6¼ in. The vehicle weighs 11¼ cwt. It is powered by a 633 cm³, four-cylinder, overhead valve engine on a three-point rubber mounting. The bore and stroke are 60 mm and 56 mm respectively, and the compression ratio is 7 : 1. At 4,600 r.p.m. the maximum power output of 21·5 b.h.p. is obtained. The maximum b.m.e.p. is 113 lb/in² at 2,800 r.p.m.

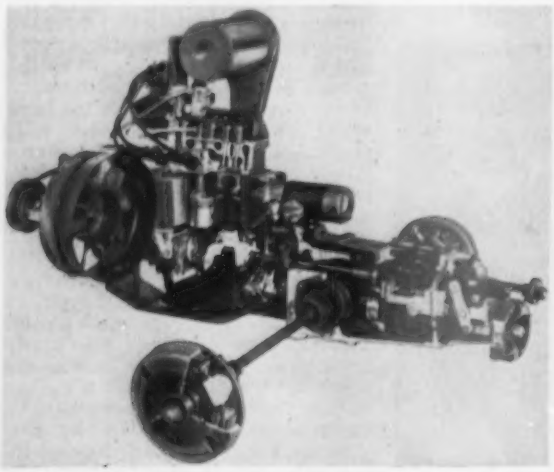
A cast iron crankcase is employed, and it houses a three-bearing crankshaft. The cylinder head, which has a built-in induction manifold, is of aluminium alloy. Although valve seat inserts are necessary with this arrangement, the fact that some saving in cost has been obtained by incorporating the manifold in the head, and also because aluminium is cheap in Italy, may mean that the cost is no more than that of a similar cast iron head, with a separate manifold, manufactured in this country. The advantages of aluminium heads, as compared with the cast iron type, are well known: an appreciable saving in weight is obtainable and the heat flow characteristics of aluminium are, of course, particularly good.

Mounted on the Weber Z2DRA downdraught carburettor is a combined air silencer and filter. The lever that controls the choke is on the tunnel on the floor between the two front seats. Fuel is fed to the carburettor by a mechanically operated diaphragm type pump of conventional design. A by-pass oil filter is incorporated in the lubrication system.

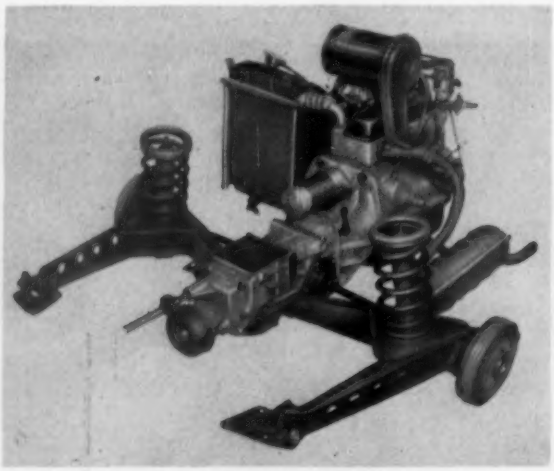
Water cooling has been adopted and the circulation is maintained by a centrifugal type pump. The fan is mounted on the pump spindle and the whole assembly is carried to the right of the engine behind the radiator. Two V-belts furnish the drive. One is fitted between the crankshaft and dynamo pulleys and the second between the dynamo and pump pulleys. This arrangement has the incidental advantage that there is a tendency for the journal loading on the dynamo bearings to be reduced to a minimum.

The fan and radiator are shrouded and a thermostatic temperature control is incorporated. This control actuates the shutter at the lower end of the air outlet ducting from the radiator. A manually operated shutter is also incorporated in this ducting to direct hot air, from the upper portion only of the radiator block, into the interior heating system if required. A coolant temperature warning lamp is mounted on the dash facia, to give warning of overheating in the event of a V-belt breakage. The starter motor is brought into operation by a lever, beside that for the choke, on the floor tunnel.

A single-dry-plate clutch is interposed between the engine and final drive and gearbox unit. Four forward speeds and one reverse, all indirect, are obtainable. The gear ratios are: top 4·88 : 1, third 7·13 : 1, second 11 : 1,



Siamesed cylinders are employed in the 633 cm³ engine, and a transmission hand brake is mounted on the rear of the gear box



A simple triangulated link type independent rear suspension system is employed

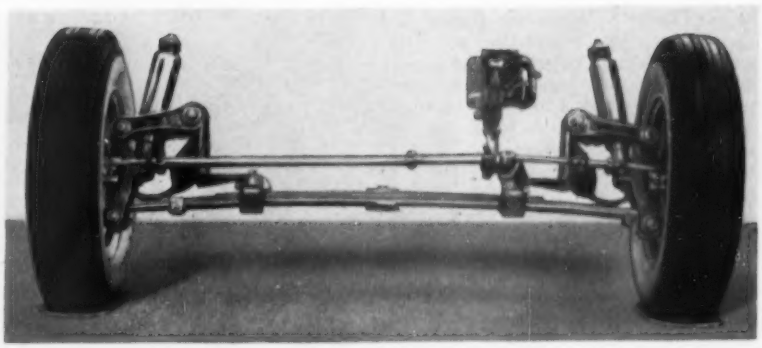
first 18·2 : 1, reverse 23 : 1. A spiral bevel final drive is employed and its ratio is 8 : 43. In top gear, the speed in m.p.h. per 1,000 r.p.m. is 12·79.

At the inner ends of the swinging half shafts, the universal joints are housed in a cupped, pressed steel cover plate bolted to the sides of the gearbox and thus are well protected from contamination by abrasive matter. Rubber bonded, splined couplings connect the outer ends of the shafts to the rear wheel hubs to transmit the drive and absorb torsional vibrations.

There are hydraulic brakes on all four wheels. Their linings are bonded to the shoes. The hand brake lever is mounted on the floor tunnel and it operates a transmission brake at the front end of the gearbox. Disc type wheels with 3½ in rims are employed, and they are fitted with 5.20—12 tyres.

The independent type suspension is employed both at the front and at the rear. At the front, a single transverse leaf-spring forms the lower arms of the double transverse link system. It is mounted in such a way as to act also as an anti-roll stabilizer. The upper arms of the system are light pressed steel wishbones. Damping is effected by double acting telescopic shock absorbers.

Coil springs are used in conjunction with a triangulated link arrangement on each side at the rear. The links each comprise two channel section steel pressings. Their ends are rubber bushed. On each side of the vehicle, one arm of the link is pivoted on the heel board and the other is pivoted on the structure immediately in front of the universal joint of the swinging half shaft. Gusset plates are welded to the flanges of the channels above and below the apex of the link to join the two arms together. The upper gusset forms the seat for the coil spring and is pierced to allow clearance for the telescopic shock absorber, which is mounted co-axially with the spring and is attached to the lower gusset. Because the axes of the pivots are set at a large angle relative to the longitudinal axis of the vehicle, a rear end steering effect is introduced when the vehicle rolls. This arrangement has been adopted to counter the oversteering tendency that is otherwise almost inevitable in such a light rear-engined car.



The transverse leaf spring at the front, which forms the lower link of the suspension system, is rubber mounted at two points

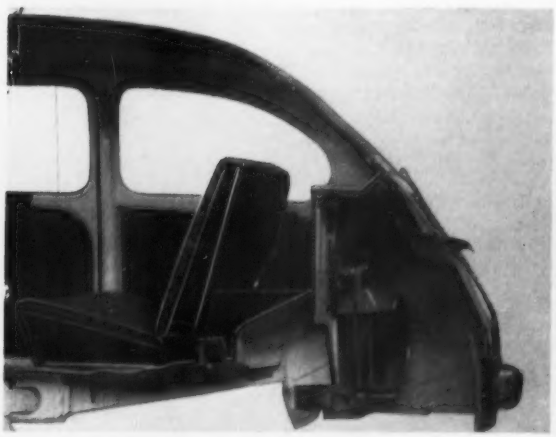
The worm and sector steering gear is used in conjunction with a 15½ in diameter wheel and a two-piece track rod. A turning circle of only 28 ft 6 in has been obtained; this is a noteworthy features, since cars of this type are in many instances kept in small garages, access to which is difficult. No doubt the small turning circle has been made possible by the fact that the engine is at the rear and therefore there is more room at the front for accommodating the wheels at a relatively large angle of lock.

Twelve-volt electrical equipment is employed. The output from the 180 W dynamo is controlled by a conventional voltage regulator. A 28 amp-hr battery is housed at the front of the vehicle. The head lamps are of the double-filament type and have polished aluminium bezels. The twin side lamps are mounted on top of the wings; they also are in polished aluminium housings, and they incorporate the flashing direction indicators. Four features are incorporated in each rear lamp: they are the parking lamp, stop lamp, reflector and flashing direction indicator. The twin windscreen wipers are electrically operated and automatically park at the ends of their travel. In addition to the number plate illumination lamp, there is also a separate light in the engine compartment. The electrical equipment on the dash includes a panel light and its switch, oil pressure, water temperature and battery charging warning lamps, and the windscreen wiper switch. The ignition switch, which is in the centre of the head and side lamp switch, is immediately below that for the direction indicators.

Body structure

The main longitudinal components of the body structure are the centre tunnel and the two sills, which are extended to the rear by the quarter panels and to the front by the dash sides and wheel valance panels. A strong cross member is formed at each end by the body panelling and the intermediate cross members include the toeboard and dash assembly, the heelboard and the rear bulkhead that separates the saloon from the engine compartment. Another cross member is formed by a top hat section spot welded by its flanges to the floor behind the rear seat.

The front cross member is of U-section. It is formed by the front panel and the rear panel of the spare wheel



A thermostat control, fitted beneath the radiator, regulates the air flow through the outlet

A top hat section cross member is spot welded to the floor behind the rear seat

well. The two panels are flanged at their lower edges where they are spot welded together. A flange at the upper edge of the rear panel of the spare wheel well is welded to the front edge of the battery container. The rear of this container is attached to the dash panel. The container is a simple box suspended below the floor of the luggage compartment in the front of the vehicle. It is braced by two strip steel stays, one to the wheel well and the other to the toeboard. Access to the battery as well as to the filler cap for the brake fluid is gained simply by lifting the rubber covering on the floor of the luggage compartment.

The floor panel of the vehicle slopes upwards at the front to form the toeboard ramp and its forward edge is bent up vertically and flanged and spot welded to the lower surface of the dash panel. A box section cross member is formed beneath the front of the toeboard by a channel section, one arm of which is spot welded to the forward vertical face of the toeboard and the other arm is flanged and spot welded under the ramp. The upper edge of the dash panel is spot welded to the front wall of the drip channel at the leading edge of the scuttle. At each side, the dash, toeboard, luggage compartment floor, and the rear panel of the spare wheel well are spot welded to the wheel valance panel.

To take the suspension loads, the toeboard ramp has a doubling plate spot welded to it. On each side, the pivots of the transverse wishbone link and the bracket that carries the suspension spring are bolted to an inverted top hat section, longitudinal member that is spot welded by its flanges under the toeboard. This member is triangular in shape, as viewed from the side, to fit the slope of the ramp in such a manner that its lower edge is horizontal. On one side, the brake master cylinder is mounted on the inner face of this member. The upper ends of the shock absorbers are carried by brackets spot welded to the wheel valance panels, which are swaged locally to support these brackets.

The upper edge of the valance is welded to a vertical, upturned flange at the inner edge of the wing. The top

The floor tunnel is a major component of the structure. It also houses the gear shift, engine and handbrake controls, and forms a duct for the heater system

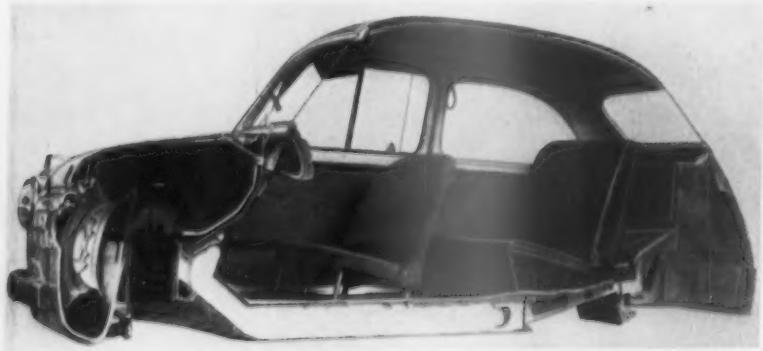
edge of this flange is turned inwards and it forms the side of the bonnet opening. Thus, there is no drip channel at the sides; the bonnet lid fits over the upturned flange to prevent the water from running inside. The edges of the bonnet lid are flanged inwards and seat on circular rubber pads, two on each side on the wings and four on top of the front panel. A fairly conventional hook type bonnet latch is employed at the front in conjunction with a separate hook type safety catch. The anti-rattle device is a 1¾ in wide, V-shaped leaf spring, one arm of which is attached to the horizontal part of the front panel, adjacent to the catch, and the other arm bears up against the front edge of the lid when it is closed.

Apparently the bonnet lid is of thin gauge steel, and it is exceptionally light. The only stiffening member is a top hat section fitted transversely, adjacent to its rear edge. This member is attached by welding its outer ends to the turned in flanges of the lid, and a simple strip steel stay is spot welded to its centre and to the lid. The weld on the lid is concealed by a chromium plated spine-strip on the exterior. The Fiat badge is mounted on the lid at the front end of this strip.

Simple strip steel hinges are employed. They are pivoted under the scuttle and extend through grommets on the dash panel. Two bolts are used to secure each to the top hat section, transverse stiffening member on the lid. This member is strengthened locally by ribbed plates at the hinge attachment points. A similar stiffening plate is welded to the flanges of the top hat section immediately behind the stay at the centre of the transverse member. The stay, in addition to supporting this member, forms the stop for the bonnet lid prop. This prop is a steel rod bent at right angles at each end. Its lower end is pivoted in a bracket on the dash panel and is spring-loaded so that its upper end bears against the stay, against which it slides as the bonnet is lifted. When the bonnet lid is fully open, the prop slides underneath the stay, where it is trapped. Therefore, it is necessary to pull the prop forward, clear of the stay, before lowering the lid.

The front panel has three horizontal bars of polished aluminium to give the effect of a grille. They are divided in the centre to make room for a circular motif of transparent plastics. This motif comprises three concentric rings spaced apart by radial spokes. The outer ring is metal-sprayed on its reverse side to represent chromium plating; the intermediate circle is transparent, and the centre one is a disc on which the figure '600' is displayed on a red-painted background. The sides of the front panel are flanged; below the headlamp on each side, the joint with the wing panel is vertical, while there is another joint, at an angle of about 45 deg from the horizontal, extending from the headlamp bezel to the upper corner of the front panel.

The bumper is of channel section, 3 in deep by 1 in over the flanges, and its width is slightly less than the overall width of the front end. It is attached by two bolts, each about one-third inboard of the outer end. These bolts are passed through the bumper and the front panel; a U-shaped distance piece is passed over each and is interposed, flanges downwards, between the two components. This distance piece is aluminium painted. A strip steel stay with its end bent at right angles to form attachment lugs is used to back up each of the bumper attachments. These stays extend between the front and rear panels of the well for the spare wheel, which they help to locate.



The petrol tank, battery and spare wheel are carried at the front to improve the weight distribution

At the rear, the main cross member is of box section. It is formed by the skirt panel below the lid of the engine compartment and is closed by an inner panel. The skirt panel is a shallow top hat section and the closing plate is welded to its flanges. This assembly is secured to the rear quarter panels by two bolts at each end, so that it can be readily removed in order that the engine can be withdrawn. Its ends are reinforced with a heavy gauge strip where the bolts pass through, and a chafing strip is interposed between them and the tail end of the rear quarter panel. At the centre, the cross member carries a bracket for the single-high-point rear engine mounting. There are two more mountings, one each side of the gearbox. The bumper at this end of the vehicle is attached in a similar manner to that at the front and is the same shape. However, instead of there being a stay between the two vertical walls of the box section member, the inner wall is pressed rearwards locally to contact the outer wall, and the bolt is simply passed through the two panels and the bumper attachment assembly and tightened.

A vertical panel approximately parallel to the longitudinal axis of the vehicle closes each side of the engine compartment and supports the edges of the rear opening. Its front edge is flanged and spot welded to the bulkhead behind the rear seat squab. Forward of the bulkhead there is no inner panel.

The sills are of box section. They are about 3 in wide by 5 in deep over the flanges. At the front end there is an unfilled flanged joint between the sill outer panel and the front wing. This joint is horizontal and its line is continued to the rear by a line pressed in the door. On the quarter panel, this line rises to form an imitation rear wing. Another joint is formed vertically just in front of the rear pillar, but this is filled. It appears to be the only filled joint on the body since the rear quarter panel is pressed in one piece.

A simple dash facia layout has been adopted and, beneath it, the radio is carried between the arms of the Y-shaped pipe connection to the demister ducts

The other main longitudinal member is the top hat section tunnel, which is spot welded by its flanges to the floor. Its front end terminates at the beginning of the toeboard ramp, but a top hat section extension is spot welded on, and is continued up the ramp to the base of the dash. The rear end of the tunnel terminates at the heelboard, which has an extra plate welded to it to form a box section cross member. A rubber gaiter is fitted to a flange inside the tunnel to seal the rear end where the controls pass through. Behind this point, the longitudinal member is continued by a forked extension to clear the gearbox and final drive casing and carry the rear mountings of the engine. The arms of this forked extension pass under the top hat section cross member behind the rear seat and terminate at the bulkhead of the engine compartment. The transverse arms of the rear suspension links are pivoted on brackets on the forked extension, and the forward extending arms are pivoted on brackets on the cross member formed by the heelboard. The circular, rubber sandwich type mounting at the upper end of each shock absorber is carried in a bracket welded to the side panel of the engine compartment.

The tunnel and the right-hand arm of its forked rear extension is used as a conduit for the hot air for interior heating. Heated air passes from the radiator through this conduit to the front end of the tunnel, where there is an aperture on each side. A rotary, plate valve is fitted to the aperture so that it can be closed if necessary. At the upper end of the extension on the toeboard, a Y-junction is welded on, and flexible pipes are connected to it to carry the hot air to the demister ducts.

Other features

An Autovox radio can be mounted under the dash facia between the arms of the Y-pipe to the demister ducts. The control is on the right-hand side of the dash facia. A retractable aerial is mounted on the right-hand side of the scuttle. The general arrangement of the dash facia can be seen in the accompanying illustration. At the centre, between the radio control and the instrument housing, is a plastics plate, at each end of which is a switch. One of these two switches is for the wipers and the other is for the instrument panel illumination lamp. The combined ignition and head and side lamp switch is at the centre of this plate. Above it, there is a direction indicator switch.

All the instruments are mounted in a binnacle type of housing on the dash facia, above the steering column. The speedometer is accommodated in the centre of this housing. It incorporates a mileometer but no trip indicator. On the right, there is a fuel contents gauge and on the left, in a similarly shaped frame, is an oil pressure warning lamp. There are two more warning

A large plastics container on the door panel serves as a pull-to as well as to accommodate maps and small parcels

The rear seat squab can be pivoted forwards to provide room for a large amount of luggage

lamps, but they are circular in shape. One is above the oil warning lamp and indicates whether or not the dynamo is charging, and the other, which shows if the water temperature is too high, is above the fuel contents gauge.

Some of the interior dimensions are as follows. The height from the floor to the roof between the door hinge pillars is 45 in. Between these pillars the width is 48 in at the level of the rear seat cushion and 44½ in at the waist. At the front seats, the width between the door panels is 46½ in and between the waist rails 43½ in. The width between the front wheel arches is 28 in. With the front seat in the rearmost position, the distance between the front edge of the cushion and the extreme front edge of the toeboard is 28½ in. When it is in the foremost position, this distance is 23½ in. A multi-stage adjustment is provided for the seat, which in fact can be locked in any one of eight positions. The length from the brake pedal to the centre of the rear squab is 53½ in.

The doors are about 39½ in wide just below the waist and are hinged at the rear. No doubt this rear hinged arrangement has been adopted because there is not sufficient vertical length of pillar at the front to space the hinges far enough apart to give adequate support to the door. Another advantage of the rear hinge arrangement is that the door opening mechanism and its controls are all close together at the front edge, so there is an appreciable saving in cost.

There has always been considerable controversy over the relative merits of two- and four-door arrangements. In fact, the practical advantage appears to be with the two-door car, although the public generally tend to favour four. With such a small vehicle as the Fiat 600, a four-door arrangement would tend to make access to both the front and rear seats more difficult, instead of easier, because the doors inevitably would be small. The cost would be higher, particularly if both four- and two-door versions were to be offered, since extra tooling, as well as hardware, would be involved. In some instances it is impossible, and in others scarcely practical, to make the structure strong enough if the sides of the vehicle have to be cut away to the extent necessary to accommodate four doors. In any case, the extra structure needed to provide adequate strength in the four-door layout would probably have to be carried also on the two-door version, so that as many components as possible would be common to both. The resultant increase in weight would not only involve an increase in prime cost, but it also would have an adverse effect on fuel consumption and performance. With many two-door arrangements, children in the rear cannot fall out, whereas they can in nearly all four-door cars if, for any reason, a door flies open. All-round visibility tends to be better with two doors. It seems that the public should be educated to accept this common sense point of view, so that manufacturers would not be driven to provide four doors in such small vehicles when they know that this arrangement is so unsound, both from their own and the customers point of view.

Two horizontally sliding glasses are fitted in each door light. Although the Fiat engineers have accepted as inevitable the fact that, in any vehicle, draughts cannot be excluded if the windows are open, they have paid considerable attention to the prevention of discomfort of passengers. A transparent, rectangular deflector panel is hinged at its forward edge near the rear of the window opening, and it can be adjusted to deflect the draught away from the passengers. In this way, adequate ventilation is obtained without discomfort.

By using horizontally sliding windows the inner door panel has been reduced to as small a size as possible, and forms simply a frame to stiffen the edges of the door and window and to carry the lock and hinge mountings. The trim is applied to the inner face of the outer panel. This has enabled economies to be made both with regard to cost and weight. A large plastics container is secured to the trim panel at the front of the door. It is suitable for accommodating maps, cameras and other articles; a U-section, chromium plated strip is fitted over its upper edge to strengthen it sufficiently to enable it to be used as a door pull.

External door hinges are employed in conjunction with a leather check strap. The latch is housed at the front edge of the door. A knob control projects through a clearance hole in the inner panel. Below it, there is a small lever control for locking the door. A U-section rubber seal is fitted round the edge of the door. This type of seal is more flexible than the solid sponge rubber type used on most other vehicles, and it is a good feature, since it allows the door to be closed without slamming it hard. A conventional draught strip of U-section is fitted over the inwardly turned flanges in the door aperture in the body.

The whole of the floor is covered with black moulded rubber. Separate pieces are used to cover the interior faces of the sills, and the wheelarches, heelboard and rear portion of the tunnel. At the front, a single sheet covers the front floor and tunnel, whereas at the rear two separate pieces are fitted on the floor, one each side of the tunnel. A bitumen-bonded felt, about $\frac{1}{8}$ in thick, is laid on the floor under the rubber.

The roof lining is unconventional. It is a thick panel of composite material with a silver painted finish on one side. This trim is stuck in a shallow depression pressed upwards in the roof panel, in such a way that the finished face is flush with the metal surround. There are two advantages to this arrangement. One is that it is less expensive than the more conventional head lining, and the other is that it helps to prevent drumming and noise. Manufacturers have found that materials stuck on to roof panels in some instances tend to fall off after a time. However, there are available now many new adhesives that are much more effective than those that have been used hitherto, and no doubt Fiat have investigated this problem thoroughly.

Foam rubber is employed on all the seats and their squabs. In the vehicles recently exhibited, either one of two types of trim have been offered. One is a soft cloth and the other is a composite material made of nylon and another plastics. Nylon has exceptionally good wearing characteristics and is becoming popular as a trim material in the United States. When used by itself, it is expensive, but it is possible than an appreciable price reduction can be made by mixing it with other materials.

INDEXES AND BINDING CASES

Indexes and binding cases for volume XLIV (January to December, 1954) of the "Automobile Engineer" are now ready. The price of the index is 7½d., and the binding case together with index is 6s. 5d., both are post free. Alternatively, readers' copies can be bound in publishers' binding cases at an inclusive cost of 18s. 10d., including return postage. Remittances should be sent with the orders to the publishing department, Dorset House, Stamford Street, London, S.E.1.

AUTOMATIC TONGS

AN agreement has recently been reached, between Brown, Lenox and Co. Ltd., of 157, Victoria Street, London, S.W.1., and The Heppenstall Company, of Pittsburgh, Pennsylvania, for the British company to manufacture as sole licensees in the United Kingdom and Australia, the Heppenstall range of materials handling equipment. As a result, dollars are no longer required for the purchase of this equipment, which includes the Heppenstall automatic tongs.

The operation of these tongs is as follows. They are automatically locked open after each lift, and therefore can be lowered directly on to the next load. The lifting cable is paid out until the tongs rest on the load and it goes slack. This releases the mechanism that locks the tongs in the open position, and, as the lift begins, the tongs automatically close and grip the burden tightly.

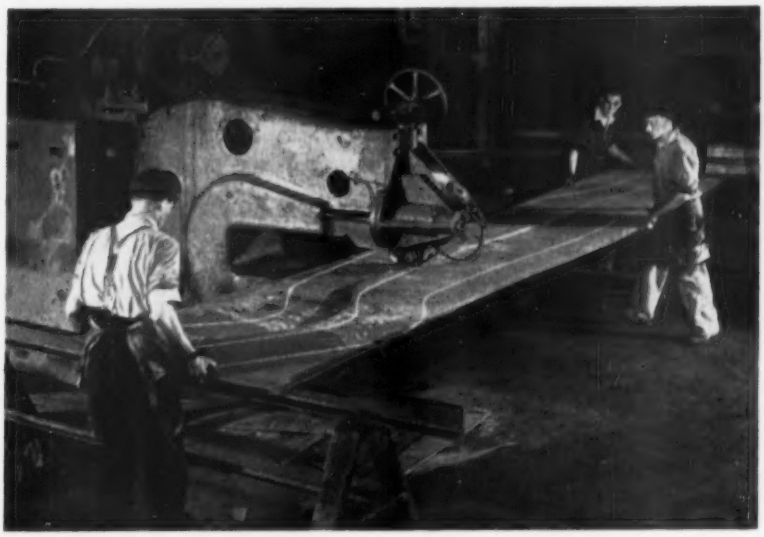
A number of variants of this equipment can be supplied to suit different applications. The tongs can be used with specially designed racks to increase warehousing efficiency. They can be provided with either two, three or four claws to suit special loads. Alternatively, special shoes can be fitted to the ends of the claws to allow the load to be rotated, to alter its attitude after it has been lifted.

CHASSIS FRAME MANUFACTURE

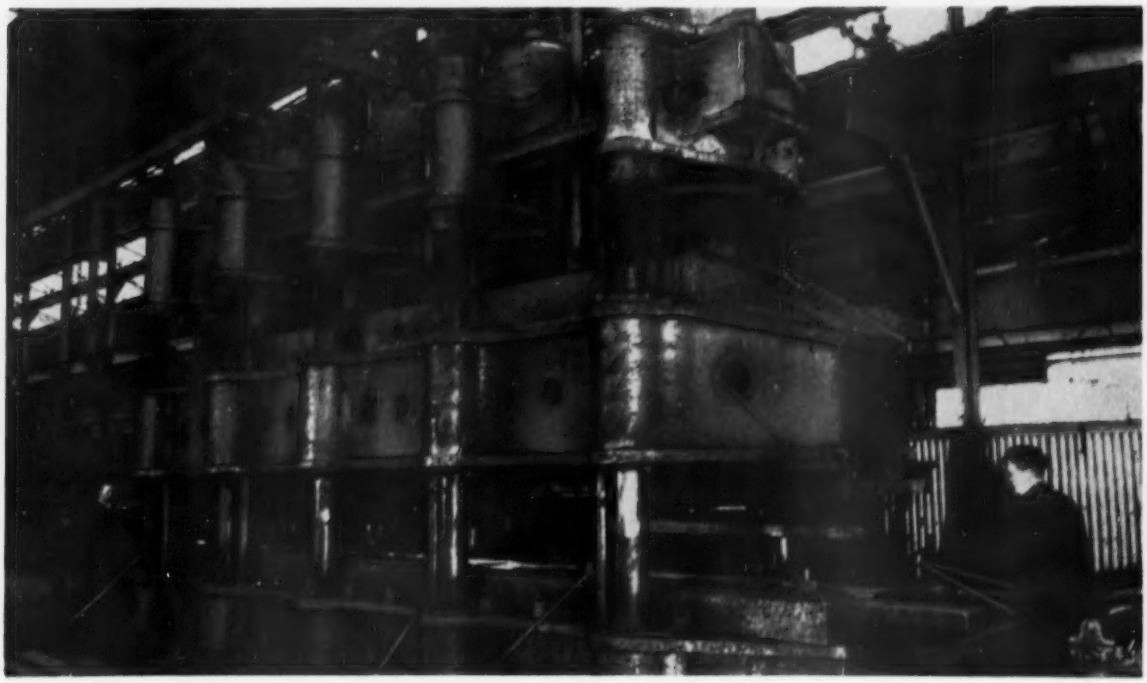
Production Methods at John Thompson Motor Pressings Ltd.

Part II. Commercial Vehicle Frames

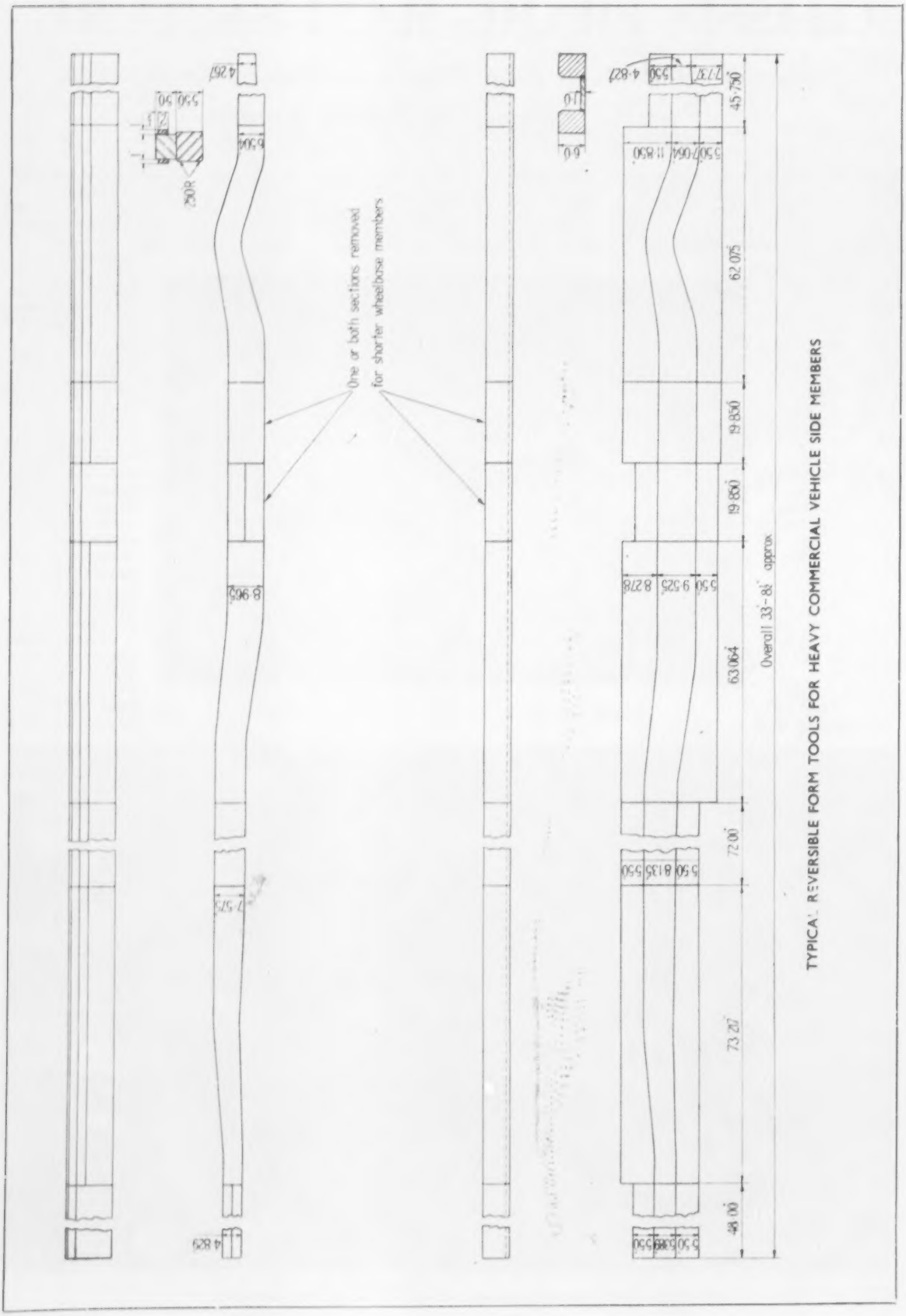
BY the nature of the duties they are expected to perform, as well as by their size and weight, the frames of commercial vehicles require methods of production differing from those adopted for passenger car frames. Sheer load-carrying capacity assumes much more significance in the design of both passenger and goods vehicle frames than is the case for car frames. In attaining the necessary rigidity to withstand dynamic stressing, essential in a car frame to ensure good steering and handling characteristics, adequate strength for load carrying is invariably built into the structure. Commercial vehicle frames, both passenger and goods, must carry heavy loads on a much greater wheelbase span and must also possess an ample margin of strength to withstand occasional or even persistent overloading. Goods vehicle frames may, furthermore, be subjected to heavy concentrated loading or to badly distributed loading. As a consequence of the relatively greater length, depth, and thickness of material, it is not practical in all cases to blank out the side members of heavy commercial frames in a press, or to form them cold. The same reasons preclude the use of double dies; in any case, the weight and cost of such dies would be uneconomic for the numbers required. Since production requirements are considerably less than those for passenger cars, the usual practice is to build reversible die sets. With these, a batch of right-hand members is formed, the punch



Cutting side member shapes on rotary shearing machine



1,500-ton hydraulic press for hot-forming side members up to 34 ft long in ½ in material



TYPICAL REVERSIBLE FORM TOOLS FOR HEAVY COMMERCIAL VEHICLE SIDE MEMBERS

Continuous milling of side member flanges to width

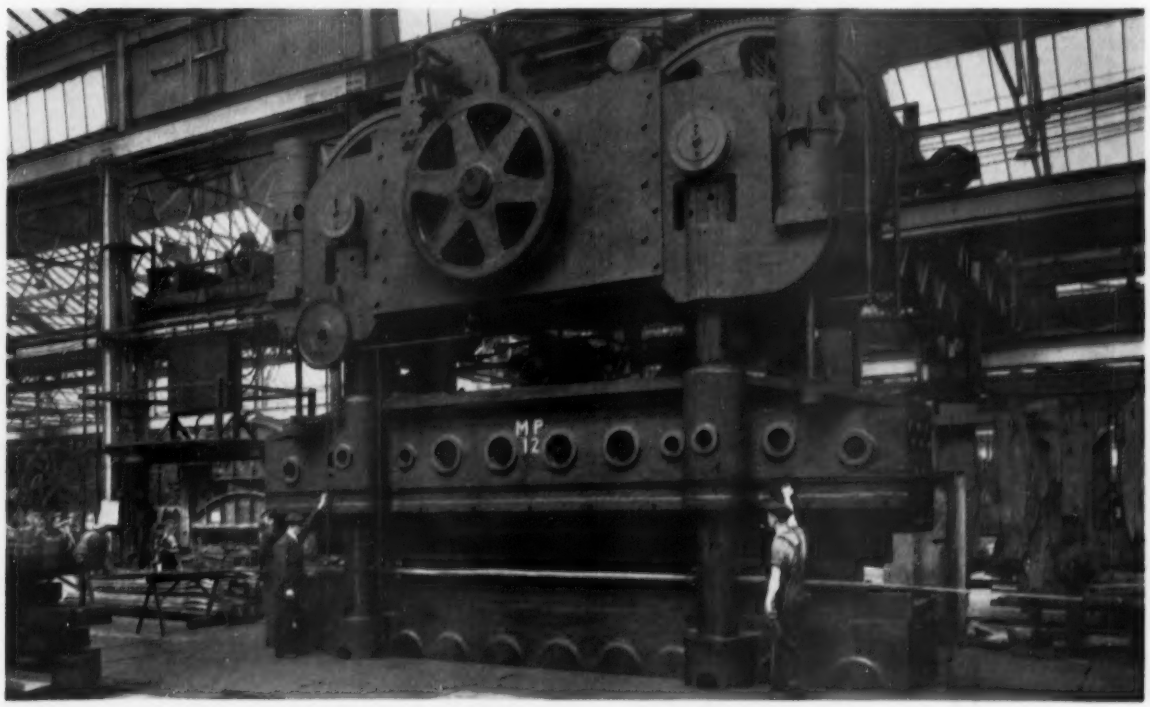
Checking side member top profile on template table

BLANKING AND COLD FORMING CAPACITIES, 2,000-TON CLEARING PRESS

Mild steel, 28/32 ton/in² tensile			
Thickness	Length of member that can be pressed		Amount of shear required to blank member 29 ft. long (12 in steelings)
	Straight	With kick-up	
$\frac{5}{16}$ in	23 ft 0 in	22 ft 7 in	0·80 in
$\frac{9}{32}$ in	25 ft 8 in	25 ft 3 in	0·62 in
$\frac{1}{4}$ in	29 ft 0 in	28 ft 9 in	0·50 in
$\frac{7}{32}$ in	29 ft 0 in	29 ft 0 in	0·37 in

and die are re-assembled, and a batch of left-hand members is then produced.

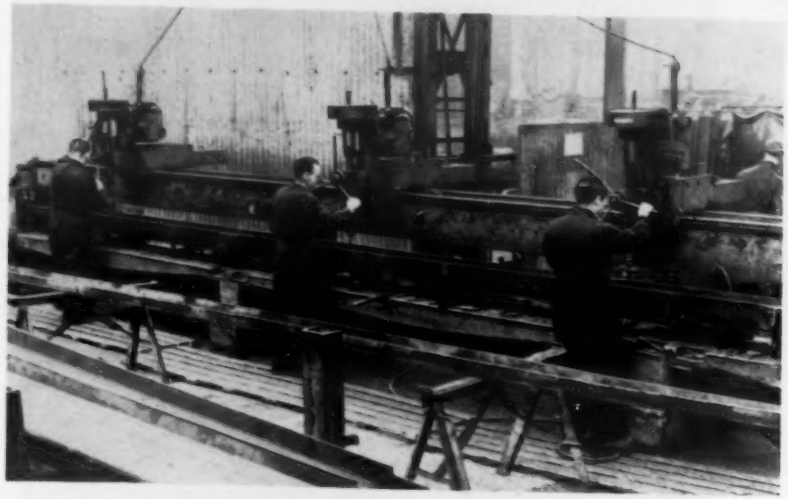
Similar considerations influence frame assembly. Although welding is widely used to fabricate cross members and to attach doubling channels or plate stiffeners to side members, the main structure of heavy commercial vehicles is invariably riveted. Welding jigs and manipulating equipment for such large and heavy frames could not be economically justified in view of the relatively small numbers required.



2,000-ton mechanical press for members up to 25 ft long

Drawing the heated blank from the furnace to the press

Straightening side member on hydraulic press



Special multi-head drilling set-up for side members

Hot-riveted assembly of typical truck frame

Channel stiffener fitted to side member

Welding perforated box plate to side member flanges

Furthermore, it is common practice for the frames to be supplied unassembled in order to facilitate transport; the final assembly and riveting or bolting being done at the customer's works. The materials commonly used for the most important component, the side member, are 28/32-ton mild steel, STA5/VA 30-ton carbon steel or STA5/V6A 35/43-ton carbon-manganese steel in plate of from $\frac{3}{16}$ in to $\frac{1}{2}$ in thickness. Plates are ordered from the steelmaker in sizes that can economically yield a pair of blanks or shapes.

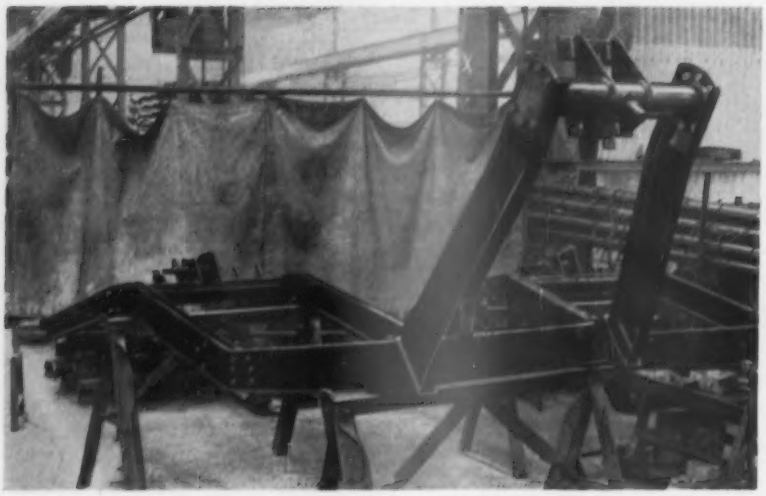
Blanking and shaping

For the lighter trucks and coaches, providing the production runs will justify die-making and shear loads are not excessive, side members are blanked from plate up to $\frac{3}{8}$ in thick in mechanical presses. Single tools are used, as distinct from the double tools common for car side members, and the 2,000-ton British Clearing presses can blank members up to 29 ft in length. The accompanying table gives examples of blanking and cold-forming capacities as performed on these presses. For these long members the steelings of the dies will be given a considerable amount of "shear." For shorter runs, the blanks are cut to shape on rotary shears. This is the general practice for producing shapes in heavier gauge material up to $\frac{1}{2}$ in thick. The shapes are marked on the plate from sheet templates and the plate is manipulated in the machine by three operators. Blanks in material of a thickness exceeding $\frac{1}{2}$ in are invariably flame cut to a profile template.

Forming

Only the lighter members, up to 29 ft long in $\frac{1}{4}$ in plate, are formed cold in mechanical presses. All members of heavier gauge are hot-formed on hydraulic presses of the firm's own design. The larger hydraulic presses are five-cylinder units of 1,000-ton and 1,500-ton capacities, and can form members in material up to $\frac{1}{2}$ in thick and up to 28 ft and 34 ft long respectively. These presses are served with water at a pressure of 2,240 lb/in^2 from the firm's central power station. The system comprises two sets of

Completed frame for overseas passenger vehicle. Overall length 34 ft



Frame with fabricated front end and bolted-in cross members

3-throw pumps, each driven by a 150 h.p. motor, and feeds through a large capacity, air-loaded accumulator.

Each press is aligned with a 37 ft long Gibbons oil-fired, twin furnace. Batches of ten blanks are heated in one half of the furnace to a temperature of 850-900 deg C in about half an hour. They are withdrawn individually from the furnace and over a roller track to the bed of the press by a capstan winch located at the opposite end of the press. The blank travels over the die on a few temporarily inserted rollers. When the blank has been transported to its approximate position, these rollers are withdrawn and it is manipulated into correct location in the die by operators working on each side of the press. After forming, the member is allowed to cool on cast iron cooling tables. Subsequently, it is normalized by reheating slowly to 850 deg C for a time sufficient to heat through the section and then allowed to cool on the tables in still air.

A typical set of form tools is illustrated. Both punch and die are built up in sections, of which two straight and parallel sections are removable to enable members to be pressed for vehicles of different wheelbases. It will be noted from the cross-sectional views that the punch is radiused on both upper and lower edges and that the die sidepieces have the standard entry chamfer at both top and bottom edges. This is necessary to enable the single tool set to form both right-hand and left-hand members. The punch sections are secured on a bolster and the die sidepieces are assembled in the trough of the press and supported transversely by packings against the sides of the trough.

After a run to complete a batch of members of one hand, the tools are dismantled and re-assembled on the press in an inverted position for a run to form a similar batch of members of the opposite hand. This method, of course, is applicable only to members that are straight in a vertical plane. Joggled side members necessitate two sets of tools, one set for members of each hand.

Setting and machining

The normalized side members are straightened on the back, or web, and on the upper flange under a hydraulic press. Flanges are then machined to correct width on Wadkin spar millers. The machine head has a total travel of 33 ft and takes a cutter up to 24 in long, which is sufficient to cover the kick-up of any normal side member, or two straight members, in a single pass. Eight pairs of hydraulic clamping cylinders hold the work down to the table. As the machine head approaches a pair of clamps, a trip lever is actuated to relieve the pressure and the out-of-balance dogs fall clear out of the path of the cutter. When the head has passed, pressure is restored and the dogs are automatically repositioned and re-clamped on the work.

After web milling, the member is checked for top face profile on a template table and, when necessary, is corrected cold by hand setting. This is a highly skilled and important operation and covers the whole of the member to ensure the squareness of the web and flanges and also contour. The member must closely fit the acceptance gauge over its entire length, not only in profile but also for the set or joggle. Flitch plates may then be welded in to strengthen the parallel centre section, or doubling channels may be fitted and welded at the flange edges to secure. In other instances, plain or perforated box plates are welded on the flange edges. Welded extensions to both front and rear ends are often a feature of chassis design.

To minimize the necessary handling, side members are drilled at one setting on specially built, full length tables. Any convenient number of motorized sensitive drills, of $\frac{3}{4}$ in diameter capacity, can be accommodated on twin T-section rails arranged above and to the rear of the table. Each drill is mounted to slide transversely in a carriage that can be moved longitudinally on the rails. Both movements are on ball bearings for easy manipulation by the operator. For long runs the side member is clamped in a drilling jig, but small batches may be clamped to the table and spotted from a drilling template.

Assembly

Before being passed for assembly, side members are proved at datum points over their entire length and for squareness of flanges and mounting faces. A pair of side members is set up on steel trestles and pressed or tubular cross members, gusset plates or angles, spring attachments and other items are built in with a few slave bolts. Riveting is on straightforward lines, a riveting team comprising a riveter, a dolly man, and a rivet heater. The rivets are heated electrically and are set with a pneumatic hammer.

Fabrication

Cross members and minor frame components are fabricated as subassemblies from pressings, tubes and plate. Flanges, brackets and attachments for these items are cut from plate on straight shearing machines or, if more elaborately profiled, are batched and flame-cut. Generally, they are jig-welded to ensure correct location and proved on a checking fixture. Apart from the instances mentioned earlier of welding-in doublers or box plates and adding front or rear extensions, welding is not extensively used in the assembly of heavy vehicle frames.

In the case of some other light frames, sets of pressings and fabricated components are supplied ready for either welded or riveted assembly by the manufacturer. For relatively heavier vehicles intended for shipment abroad in the completely-knocked-down condition, frames or sets of prefabricated members are arranged for riveted or bolted assembly.

Finishing

Completed members, sub-assemblies or frames have to be cleaned before painting and members up to approximately 20 ft long, which have invariably been worked cold, are degreased in the normal way by hot spray and rinse. After drying they are dip coated in enamel, drained and stoved by conveyance through a tunnel-type oil-fired stove.

Large members that have been formed by hot pressing and subjected to welding operations, accumulate considerable scale and slag which, unless removed before painting, would quickly set up corrosion during service. To remove this scale and slag a Wheelabrator airless abrasive shot-

cleaning plant has been installed. This equipment was specially designed for cleaning chassis frame members up to a maximum section of 16 in × 5 in.

Members are traversed through the cleaning chamber by a power-driven roller conveyor having an effective width of 3 ft 6 in and length of 32 ft. The conveyor can be operated at variable speeds up to 16 ft/min. Very large members or frames are brush or spray coated by hand and air dried. Aluminium or red oxide paints are alternatives to the usual chassis black.

Frames or pressed components for heavy goods or passenger vehicles and trolleybuses are supplied to many British and Continental manufacturers. From among these may be mentioned A.E.C., Albion, Bedford, Crossley, Dennis, Kromhout (Holland), Leyland, Maudslay, Morris Commercial, Scania-Vabis (Sweden), Scammell, Suomen (Finland) and Volvo (Sweden). Currently, the largest frames being built are for special vehicles for oilfield transportation service. The side members in ½ in thick material are 40 ft long and the main parallel channel section is 12 in deep with 4 in flanges and a welded-in box plate. Cross members of octagonal box section are also fabricated in ½ in plate. These frames are exceeded in overall dimensions only by the rail car underframes also produced at this works.

PARTICLE SIZE DISTRIBUTION

An Analyser Suitable for Use with Powdered Materials Such as Tungsten Carbide for Cutting Tools

A PARTICLE size distribution analyser, called the Micromerograph, has now been made available for sale in the United Kingdom and Europe. This instrument is manufactured in Philadelphia, and previously has only been obtainable in the United States of America. It is an automatically self-recording sedimentation balance type of instrument for producing rapidly accurate particle-size distribution analyses.

For the determination of the particle size distribution of a powder, it is necessary to break up the agglomerated sample into discrete separated particles. With the Micromerograph, this is accomplished by projecting the powder sample through a deagglomerator by means of a blast of compressed dry nitrogen. The nitrogen pressure and the orifice size have to be adjusted to suit the particular powdered material being analysed. After ejection from the deagglomerator the particles form a small cloud near the top of the sedimentation column.

The particles fall at their terminal velocities until they are stopped by the pan of the servo-electronic balance at the base of the column. Slight differences in time of fall, due to the finite size of the initial particle cloud, are rendered unimportant by the relatively great length, 220 cm, of the sedimentation column. The time required for the analysis varies from a few seconds to three hours, according to the size distribution and density of the particles.

Weighing and recording

As the particles accumulate on the balance pan, the balance beam rotates slightly on its torsion suspension. A sensing device incorporated in the balance transmits a signal to the electronic system of the instrument which, in turn, applies a current to a resisting force coil on the balance beam. The current required to keep the beam balanced is a continuous measure of the accumulated weight of the powder on the balance pan.

The milliammeter of the moving chart recorder is actuated by the same current as that which counterbalances the weight of the powder on the pan. As a result, the chart provides a record of accumulated weight against time; this record is visible throughout the whole of the determination process. Determination is complete when the chart line becomes straight, but for many applications it is satisfactory to discontinue the run before this condition is reached, that is, at an arbitrary slope of the curve or at some approximate percentage of total sedimentation.

According to Stokes' Law of Fall, the various times required for any particular percentage of the powder to settle are inversely proportional to the square of the particle size in microns and to the density ρ. The information on the chart is used to obtain a complete particle size distribution curve showing the percentage weight of particles smaller than any given micron size. A standard template is used to convert the time scale on the chart into $d\sqrt{\rho}$. These figures are then divided by the square root of the density of the powder, to obtain the diameter in microns. A knowledge of elementary mathematics is all that is required to do the calculations and, to eliminate this calculation, special templates can be supplied for powders of known densities. The density can be determined conveniently with a pycnometer.

Material	Density	Lower size limit	Upper size limit
Resin	1·3	3μ	250μ
Limestone	2·9	2μ	170μ
Nickel	8·9	1·2μ	90μ
Tungsten carbide	15·9	0·8μ	70μ

Applications

The Micromerograph is useful in production and quality control and as a research instrument. Its statistical accuracy for routine testing is high because there are several billions of particles in the sample, approximately $\frac{1}{6}$ gm. The instrument can deal with a wide variety and size-range of powders. Its approximate upper and lower operating limits are indicated by examples shown in the table.

The Micromerograph is suitable for keeping the particle size distribution of powders within safe or acceptable limits. Once the limits have been established, non-technical operators can quickly check a size distribution curve against a transparent overlay showing the area of acceptability. The Micromerograph chart and the derived particle size distribution curve form permanent records for future reference. On purchase orders for powders, Micromerograph curve limits can be specified; the distribution curve of a material tested on the seller's Micromerograph can be expected to agree closely with one made on the buyer's Micromerograph.

The Micromerograph is invaluable in any research or development programme involving the behaviour of powdered materials. Determinations can be made rapidly; this, and the inherent dependability of the results, allows the research programme to be operated at many times the rate of progress that is possible with conventional particle size determination methods. The Micromerograph has been applied to problems concerned with penicillin for medical use, tungsten carbide for cutting tools, and limestone for pigments; these are but a few instances of its wide range of usefulness. In most research applications the continuous data record of the Micromerograph is of value. Further details can be obtained from Sharples Centrifuges Ltd., at Stroud, Glouc.

RECENT PUBLICATIONS

Brief Reviews of Current Technical Books

Glass Reinforced Plastics

Edited by Phillip Morgan, M.A.

London: ILIFFE AND SONS LTD., Dorset House, Stamford Street, S.E.1. 1954. 6 × 9¼. 256 pp. Price 35s.

In recent years, the field of application for glass reinforced plastics has been widened considerably. A great deal of information exists, but hitherto, it has been scattered among a large number of technical papers and articles and therefore has not been readily available. One aim in the preparation of this book has been at collecting this information and presenting it in a form suitable for those who are only concerned with certain aspects of the subject, as well as for those interested in everything connected with glass reinforced plastics.

Since the book deals with diverse subjects, such as chemistry and production moulding methods, it is unlikely that every reader will study all the chapters. Therefore, the work has been arranged so that each chapter is largely self-contained. This, of course, has unavoidably led to a certain amount of duplication, but this is a good feature from the point of view of the reader who wishes to study only a limited number of chapters.

It is stated in the preface that some caution is necessary in the approach to this relatively new class of materials. That they have outstanding properties and possibilities is beyond doubt; but enthusiasm should be tempered by a sober appraisal of their suitability for each application. This point is also made by several of the authors of the different sections. Undoubtedly this volume is a step towards placing glass reinforced plastics on a firm technical basis.

An indication of the field covered by the book can be gained from the headings of the chapters. These headings are: Glass Fibre Forms and Properties; The Chemistry of Unsaturated Polyester and Allyl Resins; Polyester Types and Properties; Ancillary Materials; Glass Fibres with Phenolic Resins; Silicone, Melamine, Epoxide and Furane Resins; Commercial Moulding Processes; Methods of Mass Production; Tube and Rod Production; Design and Properties of Structures; Glass Reinforced Plastics in the Aircraft Industry; Glass Fibre Laminates in the Electrical Field; Automobile Bodywork and Other Transport Applications; Boat Building in Glass Reinforced Plastics; and Miscellaneous Applications of Glass Reinforced Plastics. In short, this book presents, for the first time in this country, a comprehensive account of the essential facts on the subject.

Petroleum and Performance

By E. M. Goodger, M.Sc.(Eng.), A.M.I.Mech.E., A.F.R.Ae.S., A.F.Inst.Pet.

London: BUTTERWORTH SCIENTIFIC PUBLICATIONS, 88, Kingsway, W.C.2. 1953. 5½ × 8½. 295 pp. Price 32s. 6d.

This book has been written to illustrate the inter-relationship between the properties of fuels and the performance of internal combustion engines, and to fill the gap between the popular type of handbook and the multi-volume work of reference. It deals with all the petroleum-based liquid fuels, ranging from gasoline to fuel oil, and describes their applications in engines. Liquefied petroleum gases and substitute fuels are also discussed as well as current trends in the use of fuels of other than petroleum bases for ram-jet units and rocket motors.

The first section of the book deals with the techniques employed in obtaining and refining crude oils and describes the significant properties, testing and distribution of the finished products. A description of the chemical nature of hydrocarbon materials is included so that explanations of observed phenomena may be given in greater detail. The second section opens with a survey of thermodynamic processes, and describes their application to engine mechanisms for the effective conversion of heat energy to mechanical power. Subsequent chapters cover the mechanical production of this heat energy, the combustion performance of fuels and the selection of criteria for the purposes of fuel rating. Processes involved in the supply of fuel to the combustion zone, and their influence upon combustion performance, are also described. The final chapter summarizes the requirements of engines and shows how the specification of each type of fuel has been evolved to ensure its satisfactory application.

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Technical Dictionary: English-Italian, Italian-English

By Dott. Ing. Giorgio Marolli.

Florence: F. LE MONNIER. 1954. 5¼ × 8¼. 1,075 pp.

This is the fifth edition of the dictionary by Dott. Ing. Marolli. In his preface to the first edition, the author said that the lack of an up-to-date English-Italian technical dictionary prompted him to offer his technical knowledge, gained by daily contacts with engineers and technicians of the American Army Ordnance Department, to engineers to whom a knowledge of English and Italian technical terms would be useful.

The fifth edition has been produced after more than five years' work and it covers more than twice the number of terms dealt with in the first edition. The difficulty of the author can be readily understood when it is considered how many technical terms there are for which no widely accepted definition has been officially formulated by any authoritative body, either in English or Italian. However, great care has been taken to check from every available source the meanings of all the terms in the two languages.

To assist the reader to choose the correct terms, explanatory notes and practical examples have been given, together with an indication of the special field in which each term is used. Moreover, in addition to the 1,075 pages, there are 35 pull-out sheets, on which are given illustrations of the principal engineering products, together with a key to indicate the names of the component parts of those products. For example, a cross section of the Fiat 1400 car is illustrated on sheet No. 4. The key to this illustration contains 59 technical terms. Sheet No. 5 illustrates a hydraulic brake control system, and on sheet No. 6 the longitudinal and cross sections are given of the Fiat 666N truck engine. Other sheets illustrate boring, milling, forging, grinding and drilling machines, gears, gear cutters, presses, tools and many other items of equipment.

Some idea of the scope of this dictionary can be obtained from the fact that aircraft, jet engines, boilers, oil refineries, chemical plant, buildings and electrical and steam locomotives are illustrated. Those interested in automobile engineering should find this book particularly useful, since the author is a member of the Fiat organization and, therefore, undoubtedly is an authority on Italian automobile engineering terms. Although the English spelling adopted in this new edition is that officially used in American technical books, the author also gives the English equivalent terms. For example, under "windscreen," which is marked as British, it says "see windshield," and the Italian word given under that heading is "parabrezza"; for "wing (fender or mudguard)" the translation is given as "parafango."

AMERICAN BODYWORK

Comments on Some Recent Design Trends

EVIDENTLY American stylists have taken note of Raymond Loewy's remarks, in a paper recently delivered before the Society of Automotive Engineers, to the effect that American cars generally were too lavishly treated with chromium plate and ornate motifs. Although a few of the models exhibited in 1955 still display this characteristic, the majority are less flamboyantly decorated than hitherto. The externally-mounted spare wheel arrangement that was so popular twelve months ago has, to a large extent, disappeared. This is not surprising, since it is obviously more convenient to have the spare wheel stowed under cover, in such a position that it will not interfere with access to the luggage. External mounting arrangements are more expensive and make the car more difficult to clean.

The wrap-round type of windscreen, introduced on many models last year, is now even more popular. In some designs this feature has been used to bring the pillars further to the rear to improve the forward range of vision. However, on others this is not so, because the position of the pillar is governed by the considerations of ease of access to the front seats. In this case, the pillars remain more or less in the same position as they would be with the more conventional screen arrangement, while the centre portion of the lower edge of the glass is further forward.

Pontiac Catalina

On the Pontiac Catalina, hard-top coupé, the bonnet is exceptionally wide and extends out about 1 in inboard of the head lamp bezels. This gives good access to the engine but presents difficulties from the styling point of view. To avoid the plain, billiard table effect of such a wide bonnet, two wide strips are fitted longitudinally, one on each side of the centre line, and a large swept wing type of mascot is mounted near the leading edge of the lid. The strips are grooved longitudinally; these grooves are painted black, and throw into relief the chromium plated lands between them. A crescent-shaped dummy air intake, with a chromium plated strip on its leading edge, is incorporated over the headlamps.

The windscreen is of the wrap-round type. With this arrangement, a drip channel is needed between the windscreen pillar and the vertical face of the door hinge pillar. In most cars incorporating the wrap-round screen, the channel is a simple angle section, spot welded to the upper part of the pillar.

As viewed from the side, the style of the Catalina is particularly attractive. There is no pillar above the waist at the rear of the door. The door light, of course, slides down when actuated by a winder type control, and the rear quarter light also can be retracted below the waist line by 3¼ turns of its winder control. A two-link mechanism is actuated by the winder to move the quarter light glass first to the rear to break the seal between its vertical front edge and the glass of the door light, as well as to clear the pillar below the waist, and then down into the rear quarter. The upper edge of the glass frame is shaped so that, when it is retracted, it conforms approximately with the contours of the waist which, like many modern cars of this type, dips at this point and then rises again to give a flowing line over the rear wing.

In the Catalina, no attempt has been made to give undue emphasis to this dip in the waist. Some manufacturers accentuate the discontinuity of line at the junction between the upward and downward sloping curves by fitting some form of chromium plated decoration there. In many instances, this has the undesirable effect of giving the appearance of a weakness there; for, if the chromium plated device is vertical, or nearly so, it tends to give the effect of a break at this point. This is particularly marked in drop head models which, when adorned unnecessarily in this way, sometimes appear to be sagging in the middle. In the Catalina, a chromium plated strip on each side is swept down from the screen pillar to a point almost halfway between the leading and trailing edges of the door and extends horizontally to the rear lamp. This strengthens the lines of the vehicle and emphasizes the length.

The doors are 46½ in wide. In addition to the vertically sliding light, there is a rectangular glass ventilating panel. This panel is winder operated. It seems hardly necessary to install a complicated control to operate a ventilating panel, but it is a practice that is adopted almost universally on American vehicles.

Rectangular ventilating panels present fewer installation problems than triangular ones; they have been introduced following the advent of the wrap-round windscreen, with its almost vertical side pillars. There is another marked advantage to this arrangement besides ease of installation: the panels are pivoted about one-third of the distance back from their leading edge, so, as they open, the leading edge traverses the width of the windscreen pillar but does not pass outside its profile, as viewed from the driving seat. As a result, the range of vision is not impaired.

With the more conventional triangular panel arrangement, pivoted about a vertical line through the centre of the leading edge, the framing above the pivot moves outwards, clear of the pillar, as the panel is opened. This tends to increase considerably the width of the blind spot at the eye

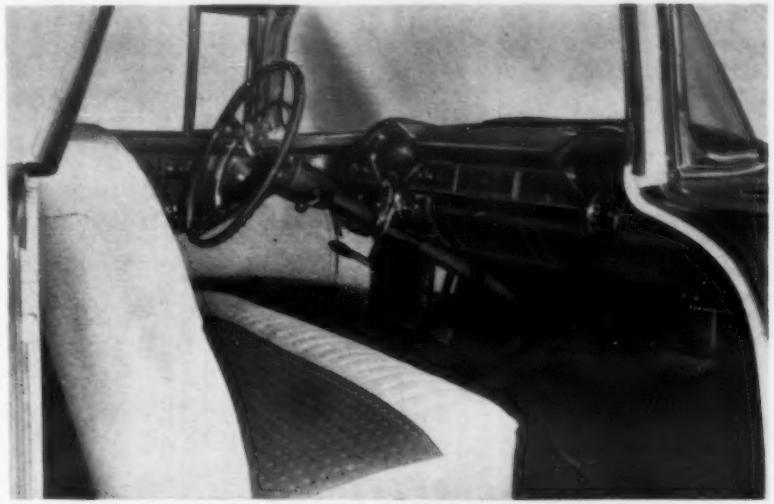
In the Cadillac Eldorado, hot air passes through a duct in the front pillar into the lower edge of the door, and thence out through louvres near its trailing edge to warm the rear passengers

When a wrap-round windscreen, with a cranked front pillar, is employed, a drip channel is necessary to prevent water running from the scuttle between the door and the pillar and into the vehicle

The Studebaker Speedster has an exceptionally low bonnet line

A large air intake is mounted on top of the bonnet lid of the Ford Thunderbird

In the Nomad version of the Chevrolet Bel Air, ample luggage space is provided as well as seats for a full complement of passengers



On both dash sides of the Chevrolet Bel Air Nomad, there is a large, louvred aperture for the heating and ventilating system

level of the driver. With both types of panel the trailing edge does not interfere with the range of vision, because the glazing frame is generally on the leading and upper and lower edges only.

The general arrangement of the side and quarter lights on the Catalina is exceptionally good for cars that are to be used in hot countries. With all the windows down and the ventilating panels open, the total length of the opening in the side is 58 in, and visibility to each side could hardly be better. The hard top protects the occupants from the hot sun, while adequate ventilation is obtainable if the windows are open. From the point of view of all-round visibility, the wide rear light also is a good feature.

A detachable panel is fitted in the opening for the wheel in the rear quarter panel. This feature is currently popular on American vehicles. In this instance, no attempt has been made to conceal the break-line between the detachable panel and the quarter. Instead, it is emphasized by a lip pressed in the panels, which extends along the lower edge of the body from the forward edge of the front wing to the rear of the sill, whence it sweeps up over the break-line of the detachable panel and extends horizontally rearwards to the top of the bumper. The detachable panel, of course, has to be removed for wheel changing.

At the rear of the vehicle, the upstanding wing crown type of design is employed. To solve the difficult construction problem that this arrangement introduces, the rear part of its upper edge, and its trailing edge, is covered by a wide strip similar to those on the bonnet. This strip conceals the panel joint. Two narrow strips conceal the joints between the two lamps and between the lower lamp and the bumper. The upper lamp houses the tail light and the lower one the reversing light.

The rear bumper is in three pieces. One, at the centre, is cranked up over the number plate, and its downswept ends are bolted one to each side piece. The general arrangement of the assembly is such that the outer components of the bumper tend to take the heaviest knocks; that is, they extend furthest to the rear.

In the Cadillac Eldorado, the over-centre spring-loaded flap under the fairing for the rear lamp pivots upwards into the panelling to give access to the petrol filler cap

These outer components are exceptionally securely mounted. The bumper irons are attached at three points on each side. One attachment is near the leading edge of the part of the bumper that is swept round the side of the vehicle. This gives excellent protection against glancing blows, which, of course, are more commonly experienced than blows in the centre. The iron from this forward attachment extends inwards and it is secured to the rear face of the frame cross member; thence it is taken diagonally to the inner end of the outer component of the bumper. A second iron is fitted between the cross member and the rearmost point of the outer component of the bumper, where it sweeps round the trailing edge of the rear wing; it is attached to the frame cross member by the same two bolts that secure the other iron. This arrangement is much better than that commonly adopted, that is, the attachment of the forward ends of the bumper to the body panels.

Cadillac Eldorado

So far as the front end is concerned, there is not much in the Cadillac Eldorado to interest designers in this country. To European eyes, the grille and bumper arrangement appears to be excessively heavy, since it comprises large areas of chromium plate. The general lines of the arrangement are such as to accentuate horizontal features and therefore to give the impression of great width and comfort.

To provide clearance at the centre, for the mechanical components, and also to avoid a great width of plain surface, the bonnet top is fairly high, but drops sharply on each side and is tapered in plan. There are only two ornamental features on the lid. One is an aeroplane-like mascot with its wings extended straight back, instead of laterally, and with a figurehead at the front. This mascot is chromium plated and is 15 in. long. It therefore accentuates the longitudinal lines of the bonnet, which, because of its taper in plan, otherwise would probably appear to be short by American standards. The other ornamental feature on the bonnet is a V of yellow metal mounted forward of the mascot. Between the arms of the V is a heraldic type of badge, also of yellow metal, with a coloured enamel design on it. The contrasts between the yellow metal, chromium and coloured enamels give a pleasing effect.

As in many other cars from the other side of the Atlantic, the fronts of the wings form a hood over the headlamps. The aperture in which each headlamp bezel is mounted is eye-shaped; a line pressed in the wing

In the Pontiac Catalina, chromium plated strips are used to conceal the panel joint at the trailing edge of the rear wings

The front seat squabs of most American two-door vehicles pivot inwards and forwards, instead of straight forwards, to give access to the rear seats, as in this Chevrolet Bel Air

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It is of interest to speculate as to whether the front end styling of the Packard Clipper could be combined with the rear light of the Pinin Farina Fiat 600

panel extends from its outer corner to the rear, passing horizontally over the front wheel and terminating just forward of the scuttle.

A similar horizontal feature is incorporated in the rear quarter but it is of more or less semi-circular section and at the rear it forms part of the tail lamp housing. An advantage of this arrangement is that the outer edge of the tail lamp is less than 1 in inboard of the widest point of the vehicle, but the pressing is susceptible to damage. The reversing lamp on each side is immediately inboard of the tail lamp, and a small reflector is set between the two, but slightly above them. This reflector is mounted in the lower end of the chromium plated strip that conceals the panel joint at the crown of each upstanding wing. The upper part of each wing is of narrow section, almost exactly like the popular conception of a tail fin of a high-speed aircraft. The chromium plated strip, which extends along the top and down the rearward raked edge of this fin, tends to accentuate the long lines of the body. These lines are further accentuated by a thin chromium plated rubbing strip along the length of the semi-circular section pressed in the quarter panel immediately in front of the tail lamp.

An access flap to the filler cap is partly concealed under this semi-circular section pressing in the quarter panel. It has an over-centre sprung hinge and lifts upwards to pivot into the quarter panel. It is immediately above the bumper end, which at this point is of very deep section. This is a good feature because the stains due to fuel being spilt by careless filling would not be visible. Presumably there is some sort of internal baffling to prevent spillage of fuel from this low filler tube when the vehicle is being cornered. The arrangement obviously has been designed for the home market in America, for it would be difficult to fill the tank from anything but a conventional nozzle at a fuel station.

The ends of the rear bumper are separate components. They are shaped to wrap round the rear quarter panel and have funnel-shaped apertures, about 4 in inside diameter, formed at their rear ends. The exhaust pipes discharge through these apertures. Number plate illumination lamps are housed in the over-riders bolted on top of the bumper.

A metal tonneau cover is fitted. It is in three pieces: the rear edge of the centre portion is located by two pegs, one near each end, and its front edge is pulled down by two toggle clips on to the seat squab. The inner ends of the side pieces are held down under the ends of the centre portion. Their outer edges are fitted with tongues, which are sprung under the upper edge of the rear quarter panel. A hide, skirt piece is fitted round the front end and inner edges of each side piece of the tonneau cover. On each skirt piece there are five press studs, by means of which the assembly is attached to the interior, hide trim. The whole of the trim is in blue and cream, and looks well with the cream painted, deep interior waist rail, the lines of which are continued by the lower half of the facia.

The trim on the seats and doors is quilted. To obtain this effect the hide is cut into relatively small rectangular pieces, which are machine sewn together, and buttons are fitted at the corners of the pieces and tied down to obtain the dimpled, or quilted, effect. Although the sewing involved with this arrangement must add to the cost, this tendency no doubt is counteracted to a certain extent because selection of blemish-free portions of hide is so much easier when only small pieces are required.

Another unusual feature of this car is the rectangular foot-mats on top of the floor carpet. There are four of these, one on each side at the front and two at the rear. They are each made up from eleven 1 in wide rubber strips held together under T-section retainers on a base plate screwed to the floor.

The heater system, also, is unusual in that the air ducts are continued into the doors. With this arrangement, it is relatively easy to provide demisting for the side screens. There are two heaters, one on each side of the dash. Air enters them through a scuttle vent and, after passing through the heater element, is taken out on each side forward of the dash through a large diameter flexible hose to the blower, which is mounted under the adjacent bonnet surround. Thence the heated air passes through another flexible hose into a conduit between the dash and scuttle side panels. There is a louvred aperture in the dash side panel on each side to supply air to the front. Two more apertures, one in the door hinge pillar and the other in the leading edge of the door inner panel,

Most American cars have a hood formed along the upper edge of the dash facia, as in this Cadillac Eldorado, to eliminate reflections at night. In many designs hide trim is applied to this hood

The headlamp arrangement of the Chevrolet Bel Air is of a type commonly used on American vehicles, and the forward rake of the front end is a feature that is becoming increasingly popular

come together when the door is shut. The hot air passes through these into another duct in the door, at the rear end of which is a louvred aperture to distribute air to the space between the front and rear seats.

The demister slots are served by separate flexible pipes from the main system. Although the ducts are wide and extend along all the forward facing edge of the screen, they do not demist the wrapped-round portion and the sides. This is another problem that is associated with the wrap-round windscreen arrangement.

An interesting feature of the rectangular vent panels fitted on this vehicle is that a small drain channel is mounted on its lower glazing rail. This is because, when the panel is open, its leading edge is inside the car. Therefore, if this channel were not fitted to the lower edge to conduct the water outside the car, water could run down the glass into the vehicle and mark the trim.

Packard Clipper

At the front end, the styling of the Packard Clipper is unusual. Its main features are arranged in a transverse plane inclined from the vertical in such a way that the upper edge is forward of the lower one. This, as can be seen from the illustration, gives an unusual but pleasing effect. It is interesting to speculate how such a front end styling would look in conjunction with the rear light arrangement of the Pinin Farina Fiat 600 described elsewhere in this issue.

The grille comprises an upper and a lower transverse component, and the two are spaced apart by a multiplicity of narrow vertical bars. These bars tend to accentuate the vertical spacing of the two horizontal features, which otherwise would be too predominant. In the centre, there is a ship's wheel type of motif. The bumper is of large cross section and has buffer type over-riders, and the lower bar of the grille which is of light cross section, is swept up round these over-riders.

On the sides of the vehicle, the line of the upper bar of the grille is continued by a chromium plated strip, which passes horizontally, at the level of the top of the opening for the wheel in the wing, to the middle of the front door. Each headlamp is surrounded by a large, shallow chromium plated pan, which is approximately semi-elliptical in front elevation and which is parallel to the forward inclined plane of the remainder of the front end. The straight edge is the minor axis of the ellipse and it rests on the top horizontal bar of the grille. An extension of the wing panel forms a hood over each lamp, and the leading edge is also parallel to the inclined plane.

A flashing indicator, between the arms of a V-motif, is mounted between the two bars of the grille, immediately below each headlamp. To break up the plainness of the wide bonnet, a flute, similar to that used for many years on Vauxhall cars, but much wider, is pressed in each side of the lid. The mascot at the front of the bonnet is in the form of a swept-back winged sphere mounted on a chromium plated strip on the centre line of the lid.

Packard have introduced an ingenious feature to help to overcome the difficulties of wiping the wrap-round screen. The arm of the wiper is pivoted at its hub and spring-loaded against the screen in the usual manner. Round the hub is a plate in the form of a segment of a circle and attached to the stationary part of the wiper assembly. This plate is not plane, but instead is bent to form a cam. It registers in a U-shaped follower on the arm of the wiper. This follower is lined with a plastics material to give good wearing characteristics and to prevent rattles or squeaks. The effect of this cam arrangement is to alter the angle of the arm relative to the screen as it traverses the wrapped-round portion so, unlike more conventional wipers, it does not traverse in a plane arc. These wipers sweep a large area and so are quick-acting to keep the screen clear in even the most torrential showers of rain.

Adjacent to its upper edge the windscreen is tinted green to prevent glare from the sun. The side lights are of Solex Doulite, which is said to keep down the interior temperature, and to reduce glare from direct sunlight. It also prevents the passage into the car of the components of sunlight that cause the trim to fade.

Two types of cloth are used for the trim. On the seats a woven nylon type of material is used to give extremely good wearing properties, whereas the trim on the doors is washable plastics sheet. The facia is a flat panel with a hood extending over its full width to eliminate reflections at night. This flat facia arrangement is in general conformity with the external styling of the vehicle, notably of the front end.

A wide chromium plated strip is fitted over the sill outer panel between the wheels to conceal the two unfilled, vertical joints. These joints are positioned one immediately in front of the rocker panel and the other just behind the front pillar. At the rear, removable covers are fitted to the opening over the wheels. As in many other American models, the rear and reversing lamps in the tail end of the upstanding rear wings are exceptionally large. The bumper, in plan view is shaped to follow the contours of the rear end; there are no other features of particular interest at the back.

The forwardly-inclined plane, front type of style, adopted in the Packard Clipper, is also used on the Chevrolet Bel Air convertible, but it is not so flat as on the Packard. The grille is of elongated, rectangular shape with a rectangular mesh in it. Above the headlamps, the hoods formed by the leading edge of the wing are not unlike eyelids, with their outer corners extended back along the body sides and emphasized by a chromium plated strip. The flashing indicators are below the headlamps and are approximately semi-elliptical in shape to match the lines of the hoods; their lower edges are straight and are on the major axes of the ellipses.

Inside the vehicle, the seats hinge forwards and inwards so that access to the rear seats is facilitated. When the squabs are in the upright position, two taper faced pegs at the base of each rest on wedge-shaped seatings on the rear edge of the cushion pan. These pegs and seating pad assemblies are fitted one on each side and the tapers on the pads are inclined inwards so that the squab is held firmly, as between arms of a V. This arrangement is common in cars produced on the other side of the Atlantic.

LIGHT ALLOY FINISHING

INCREASED interest in the use of unpainted finished aluminium alloy has been aroused since it has been used experimentally for railway carriages by the London Transport Executive. A method has been evolved by the Aluminium Development Association for providing a clean finish. It involves the use of a modified Black and Decker, 6 in heavy-duty, portable electric saw to remove the projecting beads from welded light alloy sheets, and thus to obtain a flush surface.

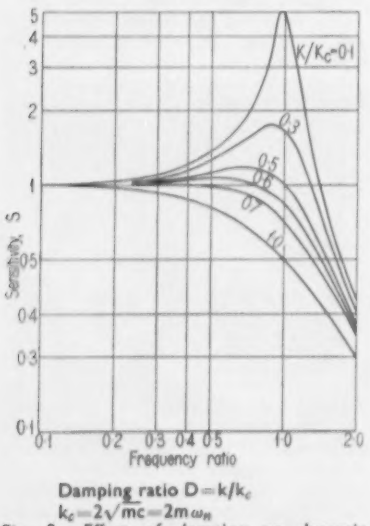
The saw was modified by mounting on the blade shaft a milling cutter, 2¾ in diameter by ⅛ in wide, and by removing the lower blade-guard and fitting in its place an adjustable guide plate of teak or hardwood. This guide plate has to be of non-metallic material, otherwise it would scratch the light alloy sheet. The cutter speed for this application is 2,000-3,000 ft/min, and the guide plate is adjusted so that approximately 0·001-0·005 in of metal is left upstanding when the bead has been cut down. This upstanding portion is then removed with a disc sander. It has been found that after the weld beads have been removed, a No. 44 Orbital Sander produces an excellent overall effect on the alloy surfaces. It gives a mechanically produced, scratch finish that has a sufficient degree of reflectivity and metallic lustre to prevent the development of patchiness in service. Accidental scratches and marks do not show up readily on this finish.

DYNAMIC LOAD DETERMINATION

The Design and Use of Accelerometers

VEHICLES now have to withstand higher inertia loading than ever before, while impact and fatigue loading also tend to become increasingly severe; moreover, material costs are continually rising. These factors, together with the need to obtain the best possible fuel economy because of high prices, have made it necessary to reduce vehicle weight to a minimum. It is becoming apparent that crude rule-of-thumb methods of design are no longer adequate: the designer needs to know exactly what are the loads and stresses in different parts of the vehicle, so that he can adopt the most economical layout and employ the materials to the best possible advantage. Stress analysis must take into account not only static loading but also impact and inertia loads. Therefore, a properly designed recording accelerometer can be a most useful tool; however, it is essential that the characteristics of the instrument meet certain well-defined requirements. In the past, research and development personnel have not always paid sufficient attention to these requirements and, as a result, incorrect conclusions have been drawn and designers have been supplied with misleading information.

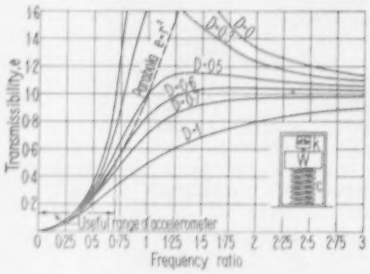
There are plenty of different proprietary accelerometers currently available, their designs generally are based on direct recording, the use of strain gauges, differential transformers or piezo-electric pick-ups. Most of the units are of the seismic type, that is, they are based on the principle of the seismograph used to measure earthquake motions. The instrument consists of a case containing a mass suspended by one or more springs. If the mass is heavy enough, the spring sufficiently soft and the frequency f_a of the vibration to be measured is high enough relative to the natural frequency f_n, the mass remains almost motionless and the relative motion between the case and the mass is an almost exact reproduction of the vibration that is being measured. To meet these requirements, the ratio f_n/f_a must be greater than 4 and damping D less than 0·1. On the other hand, if $f_n/f_a<0{\cdot}7$ and $D=0{\cdot}6$ to 0·7, the mass will tend to follow the motion of the case and the relative motion between case and mass will be almost exactly proportional to the instantaneous acceleration of the case.



Damping ratio $D=k/k_c$

$k_c=2\sqrt{mc}=2m\omega_n$

Fig. 2. Effect of damping on dynamic sensitivity



Transmissibility, $e=\dfrac{\text{displacement of mass}}{\text{displacement of housing}}$

Frequency ratio, $r=\dfrac{\text{forced frequency}}{\text{natural frequency}}=\dfrac{f_a}{f_n}$

Fig. 1. Effect of damping on accelerometer performance

The damping imposed upon the suspended mass is usually expressed in terms of damping ratio D. This is the ratio of the actual damping to the critical aperiodic damping, which represents the amount of damping that causes the motion to lose its vibratory character and is expressed by:

$$k_c=2\sqrt{mc}=2m\omega_n, \text{ lb-sec/in,}$$

where m is the mass, lb-sec^2/in, c is the spring rate, lb/in, and ω_n is the circular frequency, rad/sec. If k is the actual damping of the instrument, then $D=k/k_c$, which determines the distance by which the mass, if displaced and then suddenly released, will overshoot the zero position. The ratio of overshoot to the initial displacement is given by:

$$e^{-\pi D/\sqrt{1-D^2}}$$

where $e=2{\cdot}7183$. With an undamped system, that is, $D=0$, the mass overshoots the equilibrium position by 100 per cent; for $D=0{\cdot}7$, overshoot is reduced to 4·5 per cent, while for critical damping, $D=1$, there is no overshoot. The effect of the magnitude of D on the mode of vibration is shown in Fig. 1. For car shock absorbers, it is usual to aim at a value of $D=0{\cdot}3$; this condition has been obtained if, after one end of a car has been lifted and then dropped, the sprung mass oscillates three times through the equilibrium position. This check is based on the maintenance of viscous damping, with which the damping force is directly proportional to velocity, that is, laminar flow persists and the Reynolds number is less than 2,350. The damping force is $F=C\omega\cos\omega t$, while the work done per cycle is $Q=2\pi^2CfX^2$, where C is a constant, f the frequency and X the amplitude of the displacement; that is, F varies directly with f and X, while the work done diagram is elliptical in shape, and its area is proportional to f and X^2.

So far as accelerometers are concerned, once the amplitude and frequency ranges of the instrument have been chosen, the necessity for ensuring the maintenance of laminar flow damping conditions governs flow passage area determinations. If the instrument is subjected to simple harmonic motion, with the frequency f_a varying and the amplitude X_a remaining constant throughout, the seismic element vibrates at its natural frequency f_n. Its amplitude X_n can be calculated from:

$$X_n=r^2X_a/\sqrt{(1-r^2)^2+4D^2r^2},$$

where $r=f_a/f_n$ is the frequency ratio.

The values of the amplitude magnification factor, or transmissibility $e=X_n/X_a$, as determined from the above equation, are plotted in Fig. 1 as a function of the frequency ratio r and the damping ratio D. If r is small relative to unity, its value can be derived from $r=\sqrt{X_n/X_a}$, or $X_n=r^2X_a$; that is, the displacement of the seismic mass is proportional to X_a^2, or to the acceleration applied to it. Because of this dependence, the useful range of an accelerometer extends up to a value of $r=0{\cdot}7$, provided $D=0{\cdot}6$ to

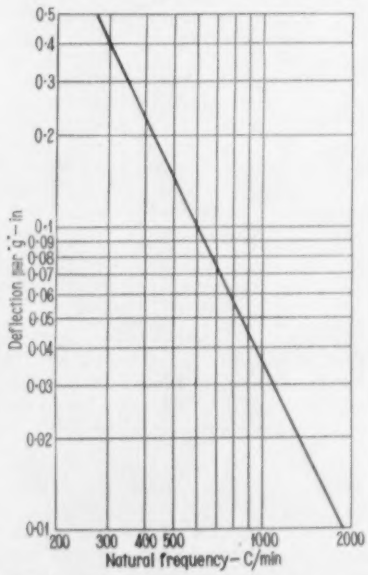


Fig. 3. Effect of natural frequency on sensitivity

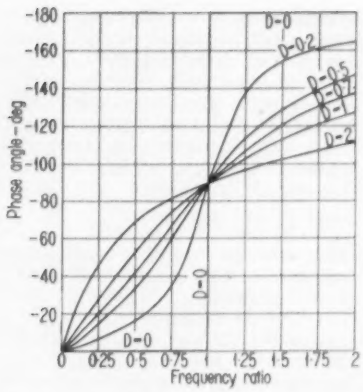


Fig. 4. Effect of damping on phase angle

0·7; consequently, to extend the useful working range, the natural frequency f_n is made as high as possible. However, since the sensitivity of the unit is inversely proportional to f_n^2, the larger is the value f_n the more accurate is the accelerometer and the lower its sensitivity.

It is also necessary to consider the dynamic sensitivity, which is the ratio of response at any frequency to the static response:

$$X_a=(\omega_a^2/X_n)/[\omega_n^2\sqrt{(1-r^2)^2+4D^2r^2}]$$

Introducing $A=\omega_a^2/X_n$ where, as before, the circular frequency $\omega=2\pi f$, in rad/sec, the static deflection of the seismic mass m is given by $y=mA/c=A/\omega_n^2$, in, while the dynamic sensitivity is:

$$S=X_a/y=\sqrt{(1-r^2)^2+4D^2r^2}$$

The values of S are plotted in Fig. 2 as a function of damping ratio D and frequency ratio r and, as in the case of transmissibility, Fig. 1, sufficiently accurate response is obtained so long as r does not exceed 0·6 to 0·7. The effect of the natural frequency f_n of the seismic system on the sensitivity, as expressed in terms of deflection per "g," is shown in Fig. 3; the seismic system with its natural frequency f_n tends to follow the oscillations imparted to it at a frequency f_a. So long as $f_n>f_a$, $r<1$ and D does not equal unity, the amplitude of the seismic mass is greater than that of the forced frequency, as shown in Fig. 2. As the value of r increases, the seismic mass gradually lags behind the forcing oscillations, Fig. 4; the lag is 90 deg out of phase at resonance frequency, $r=1$, while at higher values, the mass oscillates in the opposite direction to the forcing motion. Finally at $r\to\infty$ the mass ceases to oscillate. As shown in Fig. 4, the phase distortion can be neglected for $D=0·6$ to 0·7, since it is proportional to r, although the resultant record will be out of phase with the actual acceleration. These considerations are only applicable to steady-state periodic accelerations.

If the instrument is subjected to an acceleration that attains a constant maximum value instantaneously and then maintains it indefinitely, and if damping is provided, Fig. 5, the seismic mass overshoots to indicate an acceleration of twice the actual value, while even with $D=0·3$ the recorded value would still be 1·37 of the actual. With $D=0·7$ the accelerometer overshoots to about 1·05 of the actual value, but it reaches and remains steady at the measured value within a time slightly less than one-half of its natural period. The theoretical response to an impulse with a triangular characteristic is shown, for $f_n=0·3f_a$, in Fig. 6. Here a closer approximation to the actual acceleration would be recorded by an accelerometer having a damping ratio of 0·3 than by one with $D=0·7$.

Generally, accelerometers should have a high natural frequency, and viscous or eddy-current damping to ensure a damping ratio of 0·6 to 0·7. In these circumstances, the instruments are sufficiently accurate, provided the frequency ratio does not exceed the value of 0·7. If the characteristics of the motion include harmonics of frequencies higher than the fundamental, it may happen that one of the harmonics is close to the natural frequency of the instrument; nevertheless, if the requirements already quoted are met, the higher harmonics in the acceleration will be reduced and practically suppressed, provided their frequency is high enough.

To ensure that accurate results will be obtained, the value of the damping ratio must be known. This is particularly important with home-made

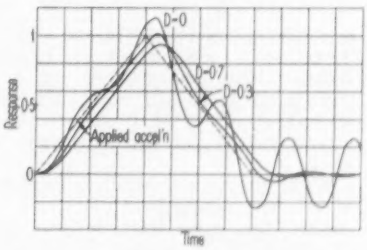


Fig. 6. Effect of damping on response to a pulse with a triangular characteristic

accelerometers. If the weight W, lb, and therefore $m=W/g$, lb-sec^2/in, and the spring rate c of the seismic mass are known, all that is necessary is to determine the coefficient of viscous damping k, lb-sec/in, and the damping ratio:

$$D=(k/2)\sqrt{g/cW}$$

However, it is not essential to use this cumbersome method for the determination of k, since D can be determined

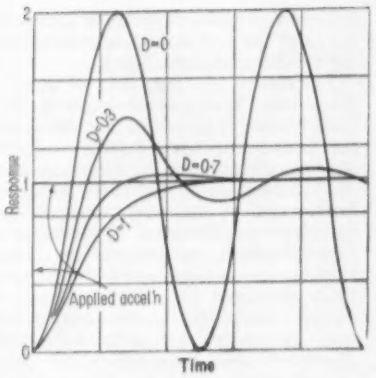


Fig. 5. Effect of damping on response to sudden acceleration

with the help of the logarithmic decrement δ. This is given by the difference between the logarithms of two consecutive amplitudes X, measured at the instants t and $t+1$, that is:

$$\delta=\log_e X_t-\log_e X_{t+1}=2\pi D/\sqrt{1-D^2}$$

The ratio between any two consecutive amplitudes is $X_t/X_{t+1}=e^\delta$ which, in Fig. 7, is given as a function of D for one and half a cycle.

Thus, to find the value of D it is necessary to note the amplitude of a number of successive oscillations and plot their logarithms on a linear scale; then δ is given by the line connecting the peaks of the curve. For example, if $X_t=0·04$ and $X_{t+1}=0·00605$,

$$\log_e X_t=2·3026\times\log 0·04=2·3026\,(0·60206-2)$$

and

$$\log_e X_{t+1}=2·3026\times\log 0·00605=2·3026/(0·78176-3)$$

respectively. Consequently:

$$\delta=\log_e X_t-\log_e X_{t+1}=2·3026\times 0·8203=1·892$$

and $e^\delta=6·65$ and $D=0·288$, Fig. 7.

The value of D can be ascertained with the help of a vibrating table, by means of which the accelerometer is subjected to vibrations at constant amplitude over a suitable frequency range. The resonance frequency, $r=1$, and its amplitude X_n, is determined, together with amplitudes X, at a number of frequencies ω, $r=\omega/\omega_n$. The value of the damping ratio is then obtained from:

$$D=(1-r^2)X/(2\sqrt{X_n^2-r^2X^2})$$

Alternatively, since the maximum transmissibility e depends upon the value of D, Figs. 1 and 8, it is possible, with the

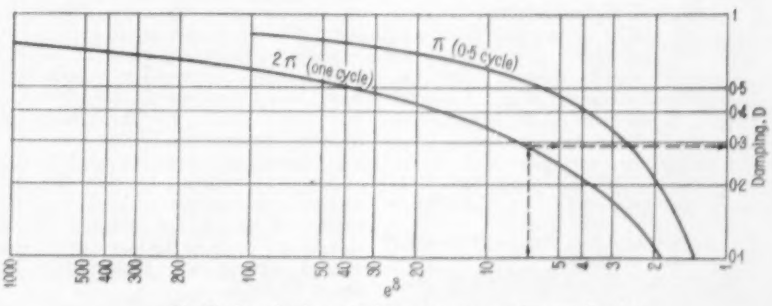
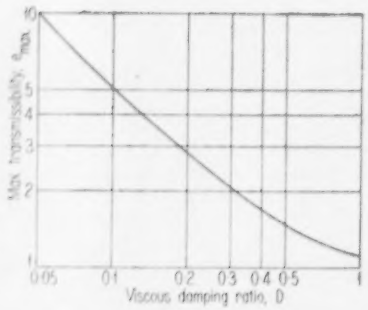


Fig. 7. Amplitude ratio between consecutive amplitudes

help of a suitable vibrator, to ascertain e_{max} and the corresponding value of D can be obtained from Fig. 8.

To ensure the recording of correct data, two fundamental requirements must be met. The relationship between the natural frequency of the instrument and the frequency of the measured oscillations must be within the required limits, and so also must the viscous damping characteristics. This stresses, *inter alia*, the unsuitability of the simple home-made accelerometers that have been employed in many instances to record maximum acceleration values encountered by vehicles over given routes. These instruments generally comprise a weight supported by a helical spring. The vertical accelerating forces cause the spring to be compressed. Thus, the deflection due to an acceleration of 1_g is equal to the static deflection under the weight. A simple ratchet or similar device locks the weight at the position of maximum deflection reached during the test. However, unless the instrument is suitably damped and the frequency ratio over the operating range is suitable,



$$e = \frac{4D^2}{\sqrt{16D^4 - 8D^2 - 2 + 2\sqrt{1+8D^2}}}$$

Fig. 8. Maximum transmissibility as a function of viscous damping ratio

completely misleading results, which bear little resemblance to true values, are likely to be recorded.

Another practice generally popular with designers for the purpose of recording values subsequently to be used as a basis for stress determination, is the clamping of accelerometers to vehicle components. For example, if an accelerometer secured to the chassis longitudinal member records 2g when running over a rough road, the conclusion drawn is that the member should be stressed for a load of three times the static load. Acceleration is determined by the rate of change of velocity, or by the second derivative of the distance covered per unit time, $\frac{d^2s}{dt^2}$. On the other hand, the tensile stress of a beam supported at both ends and subjected to steady sinusoidal vibration is determined by the deflection s, therefore, so long as the value of s is not exceeded, the stress will remain the same irrespective whether the beam oscillates between zero and maximum deflection once or a hundred times a minute; but the recorded acceleration will be different.

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VAPOUR LOCK*

Assessment of Car and Fuel Factors Affecting Vapour Locking Tendencies

IT is well known that the presence of vapour on the suction side of the fuel pump and in the pump itself reduces the pumping capacity. In severe cases, when the pump has been overheated and the engine stopped, it is only possible to re-start the engine after it has cooled. In the carburettor, the presence of vapour can cause partial obstruction to the flow, resulting in uneven pumping, jerky acceleration or difficult re-starting.

Another trouble in the carburettor, which usually occurs when the engine is stopped, is known as *percolation*. When this occurs, vapour forms in the lower parts of the fuel metering system, displaces the fuel and causes the contents of the passages to syphon into the induction pipe; this process is repeated until the system cools. The result is a very rich mixture, which creates difficulties even to the point of failure in starting, and may possibly cause stalling.

Liability to vapour troubles depends upon the ability of the fuel system to cope with the vapour as well as on the amount of vapour formed under the prevailing conditions. When a certain vapour : liquid ratio (V/L) is exceeded, incipient vapour lock or percolation will occur, and at higher V/L ratios, complete locking takes place. This V/L ratio is determined by laboratory methods outlined later in the paper. Tests on a wide range of British vehicles have shown that on the average, incipient lock occurs in cars when the ratio is 24 : 1 and complete vapour lock occurs when the ratio is 36 : 1.

While the vapour handling capacity of the fuel system is important, it is unlikely that great improvements can be effected in this respect. Rather is it in the direction of reducing the amount of vapour formed that most improvement can be expected. Both the engine design and the fuel should be suitable for operation at the highest temperature that prevails during the year. Fuel pumps, carburettors and fuel pipes should be as remote as is practicable from the hot components of the engine; they should be screened from heat radiation and insulated from conducted heat.

The under-bonnet space should have adequate ventilation at the top, so that air can circulate when the vehicle is stationary. It is not good enough to provide ample cooling when the vehicle is in motion; if carried to excess, this could lead to carburettor icing troubles in winter. Tests on 25 vehicles of different types have shown that after hard driving and stopping for a period of about 15 minutes, to allow the fuel system temperatures to soak to their maximum values, the temperature of the critical parts in the average car can exceed atmospheric temperature by about 33 deg C.

A large suction head between the fuel tank and pump should be avoided. Moreover, the fuel system should be designed to avoid flow restrictions and the consequent drop in pressure. From the evaporation aspect, a lower barometric pressure or a higher altitude is equivalent to a rise in ambient temperature of approximately 1 deg C per inch fall of mercury, or per 1,000 ft rise in altitude. However, since atmospheric temperature falls approximately 2 deg C per 1,000 ft increase in altitude, the climatic conditions at altitude are not generally so severe as at sea level. On the other hand, long steep climbs are usually associated with operation at altitude. For relatively low powered vehicles, the effect of these arduous driving conditions must be considered; because of the low forward speeds, and consequent poor cooling, the fuel system soak temperature after climbing a long stretch of 1 in 7 gradient may be as much as 8 deg C higher than those obtained after full throttle driving on level roads.

Low volatility cannot be considered as a solution, since good starting, warm-up characteristics and mixture distribution cannot be sacrificed. On the other hand, volatility should not be excessive, and fuel quality should be controlled according to the climate in which it is used. A reliable estimate of vapour-locking quality can be obtained only by laboratory determination of the relationship of V/L ratio to temperature.

In 1936, an apparatus similar to that described by Campbell, Lovell and Mulligan[1] was first used for the

*Extracts from a paper, of the Automobile Division of the Institution of Mechanical Engineers, entitled "Assessment of Car and Fuel Factors Affecting Vapour Locking Tendancy," by G. E. Sheppard, B.Sc. (Eng.), A.M.I.Mech.E., and J. G. Withers, B.Sc., M.I Mech.E.

measurement of V/L, in the Sunbury laboratories. In the United States, following an investigation of several designs of V/L ratio determination apparatus, it was decided to adopt a modified version of a design produced by the Texas Co. This now constitutes the Co-Ordinating Research Committee V/L ratio apparatus (C.R.C. 1946). The authors, however, have adopted an improved form of the original Sunbury apparatus. This was favoured because of its more compact design and easier operation as compared with the C.R.C. equipment.

The Sunbury apparatus consists essentially of a graduated glass tube, or burette, fitted with a glass jacket, for maintaining constant temperature, and a means for introducing the sample and keeping it in constant agitation. A known volume of gasoline is introduced under standardized conditions into the graduated tube, and measurements of volume are made at temperatures over a suitable range, for example, 40-70 deg C. Vapour : liquid ratios are calculated at each temperature; these ratios are based on the liquid volume of the charge to the burette, as measured at 0 deg C. The results are plotted to form a curve to show a variation of V/L with temperature.

Data given in the paper show that the repeatability, on a 95 per cent probability, is of the order of ±0·5 deg C. Further trials of the procedure at different laboratories are necessary before the figure for reproducibility can be substantiated, but so far it would appear that, on a 95 per cent probability, it is slightly better than ±1 deg C.

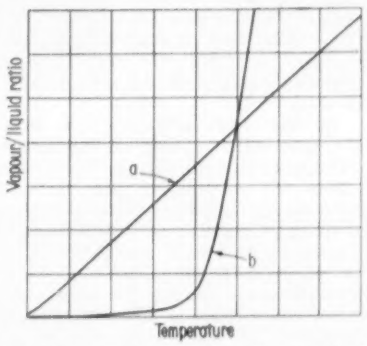
The most severe condition for most cars is associated with driving at the maximum possible speed for a sufficient time for temperatures to stabilize, followed by a stop of about 15 minutes for the fuel system temperatures to reach their maximum values. These conditions are very severe and are not normally experienced by owner-drivers in the United Kingdom where there are few long roads suitable for continuous driving at high speeds. Probably a more reasonable extreme condition is a maintained speed of three-quarters of the maximum possible, followed by a soak period with the vehicle stationary. High output in intermediate gears is another severe condition, but, except in mountainous districts, hills are not generally long enough or steep enough to cause the temperatures to rise to their maxima. Driving in city or heavy traffic can also be severe in a high ambient temperature, because of insufficient cooling. In some cars examined by the authors, the city soak temperatures obtained are the critical ones, since they are higher than corresponding temperatures obtained after driving on full throttle on an open road at the same ambient temperature. Another particularly bad combination is a period of fast running followed by crawling in a traffic jam with prolonged engine idling, as may occur on British roads during holiday weekends.

The general procedure adopted for volatility tolerance measurement is described in the C.R.C. Handbook (1946)[2], and a double system of reference fuels is described by Aldrich and others (1945)[3]. A non-volatile reference fuel base-stock is used, and two different volatile materials are blended into it. The non-volatile reference fuel is a motor spirit from which all the material boiling below 75 deg C has been removed. The two volatile reference fuels are commercially pure hydrocarbons and are:

(a) Normal pentane (boiling point 36 deg C), which in blend gives a steep V/L ratio *versus* temperature curve

(b) Iso-butane (boiling point −10 deg C), which in blend gives a relatively flat V/L ratio *versus* temperature curve

Successive tests are carried out by running the vehicle on blends of both pairs of reference fuels to find the critical blends of each which give, in the first instance, incipient vapour lock, and secondly, complete vapour lock. From a knowledge of the laboratory-determined V/L ratio *versus* temperature curves for the critical blends, the



a Iso-butane blend b Normal-pentane blend

Fuel volatility tolerance determination: double reference fuel technique

limiting V/L ratios that the vehicle system can handle can be ascertained from the intersection of the two limiting reference fuel curves as shown in the illustration. The intersection also shows the temperature of the critical part of the fuel system, from which the rise above the ambient temperature can be obtained. If the temperature corresponding to the intersection of the critical V/L curves is compared with measured soak-temperatures of the fuel system components, the point at which the trouble is occurring may be identified. The method takes no account of pressure drops in the fuel system, attention to which has been drawn by Legatski and others (1953)[4]. The authors, however, have found no discrepancy that is serious enough to indicate that such pressure drops can be appreciable in magnitude.

While the double-reference fuel technique described gives a full indication of the vehicle's performance, and enables interpretation of results in terms of any fuel, it suffers from two serious drawbacks:

1) The reference fuel iso-butane, which boils at 10 deg C below zero, is extremely volatile. For this reason, it is not possible to use predetermined V/L relations based on the nominal blend compositions, because serious loss of iso-butane from these blends is inevitable even with careful handling. It is, therefore, unsuitable for use in routine determinations unless elaborate precautions can be taken.
2) Experience has shown that cars of identical make and model can vary appreciably in their fuel volatility tolerance. Results obtained from one model, using a given fuel, indicated a variation of 14 deg C in the limiting ambient temperature for freedom from incipient vapour lock. Multiple testing of each selected model is therefore desirable, and a simplified test technique is essential for application to the rapid testing of a large number of vehicles.

To overcome these difficulties, the authors have developed a technique in which a single range of reference fuels is used. These fuels are: commercially pure iso-pentane (boiling point 28 deg C) for the more volatile end of the scale, and commercially pure normal pentane (boiling point 36 deg C) for the less volatile end of the scale, each blended with a high-octane spirit with a boiling range of 75-200 deg C.

Although the critical V/L ratio and the location of the point of trouble are not given by the single reference fuel technique, a figure of merit for the vehicle is obtained. Moreover, because the technique is easy to apply, it can readily be used by petroleum companies and car manufacturers alike. From the manufacturers' point of view, step-by-step modifications can be made, and their effects on performance obtained in spite of day to day variations in atmospheric temperature. A car cannot be considered satisfactory in temperate climates with a maximum shade temperature of 30 deg C unless it will operate free from trouble under all driving conditions on the fuel containing 45 per cent normal-pentane at a test temperature of 30 deg C, or on correspondingly more volatile fuels at lower test temperatures.

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CONTINENTAL COACHWORK

A Discussion of Some of the More Interesting Features of Bodies Built by Italian and Swiss Coachbuilders

CONTINENTAL coachbuilders, in general, tend to favour two distinctly different classes of chassis on which to mount their products. One is the high performance type for racing and sporting events and the other is the small unit that forms the basis of the more inexpensive family saloons. The reason for this is that the coachbuilt vehicles that they make are designed to satisfy two classes of customers. The first comprises those who want high performance together with a standard of comfort that is not generally offered in quantity produced sporting cars. The other is mainly made up of the middle classes of more modest means, who appreciate the quality and individual treatment of the coachbuilt vehicle, but who cannot afford either to buy or to run a large car. The limousine type of coachwork of traditional style now seems to be left almost entirely to the British manufacturers, who are supreme in this branch of the art.

So far as styling trends are concerned, many of the Continental manufacturers have adopted the ducted type air intake to the radiator. Some emphasize the horizontal features, while others adopt the rectangular shaped opening with a square or rectangular mesh grille in it. Many of the bonnet lids on models recently exhibited have either imitation or real forward-facing vents on them. Generally the reason for this feature is to provide clearance for the engine air intake silencer and cleaner unit. However, a number of manufacturers incorporate the vent simply as a decorative device to break up the plainness of the lid.

In some respects, an air vent on the bonnet lid is desirable and in others it is not. When the weather is hot, adequate ventilation is necessary to cool the engine compartment and thus to offset any tendency to vapour lock in the fuel pump and pipe lines, but in cold weather it can cause carburettor icing troubles. In general, it would appear better to have a rearward-facing vent so that the air is extracted and there is less likelihood of cold currents passing directly over the critical components.

The Pinin Farina PF200 model has a wrap-round windscreen, and the fins at the rear end improve its aerodynamic stability

At the rear, attention has been concentrated on giving an appearance of length to the vehicle. A device most commonly adopted is the rearward extension of the wings to form elongated housings, usually of approximately cylindrical or conical form, for the tail lamps. Front lamps are sometimes treated in a similar manner. The lengthening effect in other instances is obtained by horizontal features on the body sides. These horizontal features are either chromium plated or painted rubbing strips, or channel section lines pressed in the panels. They are usually in line with the tail lamps; in some instances, the pressings in the panels form part of the tail lamp housing. Nearly all the vehicles have upstanding rear wings which, in a number of models, are accentuated to such an extent that they might be better described as fins.

Many coachbuilders have devoted much effort to improving all-round vision. Some of the latest models incorporate wrap-round windscreens, and most have relatively slender glazing pillars. At the back, full width rear lights are widely used, but some are of the three-piece type. To extend the glass round the rear quarters is expensive, so the three-piece arrangement, that is, a fairly flat central piece with small curved side pieces for the quarters, is widely favoured.

Among the many coachbuilt exhibits based on the Fiat 600 chassis shown at Geneva, there was one by Pinin Farina. Its outstanding feature is the rear light which, as can be seen from the illustration, slopes at an angle of approximately 30 deg from the vertical in the reverse direction to the conventional arrangement. In other words, its upper edge is further back than its lower edge. This arrangement has many advantages and it may be widely adopted, if the public will accept it. At first sight, because of its unconventionality, there is a tendency to dismiss this layout as impracticable. However, after analys-

The left- and right-hand door pressings on the Pinin Farina Fiat 600 are interchangeable; this, of course, represents an economy so far as tooling is concerned

The rear light arrangement on the Pinin Farina Fiat 600 is difficult to blend with conventional styling, but has many practical advantages

Graber have employed a rectangular mesh in the radiator grille of both their bodies on Alvis chassis

In the Graber Super, on an Alvis chassis, an air intake is formed by the leading edge of the bonnet lid

A V8 engine is installed in this B.M.W. model, which, so far as the bodywork is concerned, is but little changed

The rear light in the Pinin Farina bodied Fiat V8 is mounted in an extension of the boot lid

ing the advantages and disadvantages of the arrangement, it becomes apparent that there is much to commend this type of rear light.

The advantages can be summarized as follows:

(1) A simpler roof panel is employed
(2) It should be possible to devise a simple head lining arrangement to suit this layout
(3) A flat glass can be used, with a consequent saving in cost
(4) Because the glass is protected by the overhung roof, it can be of lighter gauge than in more conventional rear lights
(5) The centre of gravity of the glass tends to be further forward; this is an advantage so far as weight distribution is concerned in rear-engined vehicles
(6) Because the roof overhangs the glass, there is less danger of rain drops falling on it and obscuring the rearward vision
(7) Since the side pillars that support the glass are formed by the quarter panels, which are more or less parallel to the sides of the vehicle, they offer a minimum of obstruction to the rearward vision; in fact, in this respect the layout could hardly be better
(8) The rearward slope of the pillars gives good visibility on each side at the eye level of the rear seat passengers
(9) Although in this vehicle the headroom is restricted, because of its small size, the rear light arrangement allows more than would otherwise be possible. This is because it is not necessary to curve the rear of the canopy down so sharply to conform with the general lines of the remainder of the body
(10) The arrangement makes practicable the use of press tools that are common to the doors on each side
(11) At night, glare from headlamps of following cars is reduced because of the slope of the glass
(12) During the daytime, the overhung canopy protects the interior trim from the effects of direct sunlight, so there is less risk of fading of the rear seat and parcel shelf trimming materials

On the Boano Fiat 1400, the rear quarter lights are, in effect, formed by the side components of a three-piece rear light

It would appear that there are only two disadvantages. One is that it is a difficult feature to incorporate in the styling of the vehicle. However, Pinin Farina has shown that this problem is not insurmountable. It might also be relevant to recall that there was considerable opposition to wrap-round rear lights when they were first introduced, but they are now very popular. The other disadvantage only concerns fast cars. It is that the rearward rake of the screen undoubtedly causes considerable turbulence of the air flow behind the vehicle. This may cause mud and water spray to be whipped up on to the glass, but this is by no means certain; in fact, it appears more likely that the turbulent air will sweep down from above rather than up from the sides and rear.

At the front, a windscreen with a considerable curvature is employed. In fact, it might almost be described as a wrap-round screen, but it has not the discontinuous front pillar layout that is perhaps the least desirable characteristic of most of the American cars with this feature. The screen pillars offer a minimum of obstruction in the range of vision. As viewed by the driver, they are $1\frac{3}{4}$ in wide, but in side elevation their width is 3 in. So far as tooling is concerned, the left- and right-hand door panels are interchangeable.

Since this vehicle is basically very short, the lines have been improved by incorporating a horizontal rubbing strip from front to rear on each side, and by extending the headlamp housings forward and the tail lamp housings to the rear. Thus, the front and rear overhang is greater in the Fiat-produced version. This should improve the k^2/ab ratio, which has such a marked effect on ride characteristics. Wrap-round bumpers are fitted at both ends.

Among the other models that have been exhibited this year by Pinin Farina is the PF200 on the Lancia Aurelia, 1,991 cm^3 chassis. This has a fully wrapped-round windscreen with cranked front pillars. An unusual feature of this vehicle is its rear end arrangement. Fin-like gussets are incorporated between the rear end of the wing and the cant rail, and the canopy between the front ends of these two fins overhangs the rear light to afford protection against rain and sun. The slope of the glass is conventional. This rear fin type of arrangement is becoming increasingly popular for high speed cars, mainly because it improves aerodynamic stability.

The Pinin Farina version of the Fiat 1100 was exhibited at last year's Geneva Show, and was discussed in the April 1954 issue of *Automobile Engineer*. This model has been extremely popular and so many have been sold that it has now been possible to reduce the price in Italy by 200,000 lira to 1,500,000 lira. The latest model has been slightly

The large boot lid of the Pinin Farina Fiat V8

Air intakes are incorporated in the rear quarters of the Boano Fiat 600

A Dodge chassis is the basis of the Firebomb, by Ghia of Turin. On each side a painted rubbing strip extends the full length of the vehicle; because the painted finish is not so prominent as chromium plate, this strip has had to be made of larger cross section than usual

modified. It has a wrap-round rear light, and forward extending lamp housings at the front and rear. To provide more headroom, the roof has been raised 1 in. At the front, the cross piece of the T in the centre of the radiator grille is now in line with the horizontal bar in the grille.

Another unconventional arrangement that has been adopted by Pinin Farina can be seen in the illustration of his fixed head coupé on the Fiat V8 chassis. The boot lid at the rear incorporates the rear light and part of its surround. It is hinged on the roof panel above the rear light, so that an exceptionally large boot opening is obtained.

Because of the size of the lid, a spring assister has been incorporated to make it easier to lift. This, as can be seen in the accompanying illustration, is a simple arrangement based on a single lever on each side, which is pivoted near one end. A coil type tension spring, enclosed in a tube of trim material, is attached to the end nearest the pivot. A peg at the other end of the lever registers in a slot in a long plate just inside the edge of the lid.

The length between the seat squabs and the rear edge of the boot opening is 5 ft. Over most of this length, a flat platform has been incorporated to carry luggage, golf clubs, etc. The edges at each side of the lid are extended upwards to form fins not unlike those on the PF200 model already described.

The air intake on the bonnet lid, which has been incorporated for ornamental purposes only, is of unusual design. A channel of rectangular cross section is pressed longitudinally along the centre of the lid panel, and the vent, which also is of rectangular cross section, is arranged so that it appears to seat in this channel at a point about midway between the front and rear edges of the lid. Further back, a scuttle vent is fitted. Most of the Italian and Swiss coachbuilders incorporate relatively large bonnets on their sports cars to give an impression of immense power. The Pinin Farina V8 is an example of this trend.

Another coachbuilt body by Pinin Farina is mounted on a Ferrari chassis. This body has a wrap-round rear light, but the Securit glass is in three pieces. The pillars between the pieces are slender, chromium plated, H-section extrusions. They do not follow the streamline of the cant rail as in many bodies incorporating this arrangement, but their general lines represent in effect extensions of the sides of the boot lid. No doubt this represents an economy since the main centre portion of the glass is almost flat.

A three-piece rear light is also employed on the Boano Fiat 1400. However, in this instance, the $1\frac{3}{4}$ in wide pillars between the pieces are part of the body pressing and follow the streamline of the cant rail. Another unusual feature of this model is that the spare wheel is carried on the inner face of the boot lid. It is in a dished housing, which is a separate piece welded in a circular aperture in the lid. Since the wheel is almost vertical and most of its weight is directly over the two hinges, which are at the lower edge of the boot opening, it does not add much to the weight to be lifted to open the boot lid. To give more length to the general appearance of the vehicle, the front wings are extended forward to house the headlamps. In addition, a chromium plated strip extends round the front edge of the opening in the front wing for the wheel and is then continued more or less horizontally to the extreme rear, where it terminates on the side of the rear lamp housing.

Boano have also exhibited a Fiat 600 coupé. This model incorporates the wrap-round type of windscreen, and the rear light extends round the quarters to the door shut pillars. An air intake is incorporated immediately behind each door. This device has been adopted in many rear engined vehicles; the object is to avoid spoiling the appearance of the back end by incorporating louvres in the lid.

Adjustable squabs are becoming more and more popular. On the Touring body on the Alfa Romeo Super Sprint chassis, the adjustment is effected by two three-position cams, one on each side connected by a cross shaft. There are two screw stops at the base of the squab and they seat on the cams; thus, the owner can adjust the angle to suit his individual requirements. Among the other features of interest on this model is a red lamp on the rear edge of each door. This lamp

The Daimler Regency by Ghia of Aigle is an example of how a conventional radiator grille can be successfully blended with modern styling

On this Super Sprint by Ghia of Turin, the line formed by the fairing for the rear lamp housing is an example of a feature that is becoming increasingly popular as a device for accentuating the length of the vehicle

is illuminated automatically when the doors are opened so that there is less likelihood of cyclists or other vehicles accidentally hitting the door when it is open at night. An air intake is incorporated at the front of each rear wing to encourage air circulation within the wheelarch and thereby to assist in cooling the brakes.

On the Graber Alvis Super, difficulty has been experienced in keeping the bonnet height low while at the same time accommodating an air intake filter on the carburettor. This difficulty has been solved by employing a special filter, which is like the conventional cylindrical type with its axis horizontal, but it has been specially constructed in truncated form, that is, with a flat on its upper surface, to clear the lid. To keep the under-bonnet temperature down, a vent is incorporated at the front end of the lid. It is formed by the leading edge of the bonnet lid, which is fitted with a chromium plated strip. This edge seats on a casting in the form of a flat bar with five vertical projections on it; the bar is mounted transversely on the front edge of the bonnet opening. The projections space the leading edge of the lid clear of the bar to form the air intake. Rubber buffer pads on each side form the anti-rattle device.

A ducted air intake type of radiator opening is employed. In it is fitted a rectangular mesh type of grille backed by a black painted wire mesh that is fine enough to keep out all but the smallest particles of dirt. The front apron is attached to the skirt of the front panel and a chaffing strip is fitted between the two components. This is different from the arrangement at the rear, where the apron is attached to the bumper and its leading edge is shaped to conform with, but is clear of, the contour of the rear end panelling. The rear wings are extended back to carry the tail lamps and flashing indicators.

The comfortable chair type seats are designed to give adequate support to both the back and thighs. There are two additional seats in the back. When they are not in use, the whole of the rear compartment can be closed by a flat plywood cover trimmed with hide similar to that used to cover the seats. The leading edge of this cover is shaped to fit round the backs of the front seat squabs, but sufficient clearance is provided to allow for seat adjustment.

Ghia of Aigle has produced an extremely handsome body on a Daimler Regency chassis. The traditional Daimler radiator grille at the front has been blended most successfully with modern styled coachwork. To show the grille off to the best advantage, the bumper is cranked down under it at the front. The ends of the bumper are wrapped closely round the wing panels; perhaps a little more clearance between the components is desirable.

At the rear end, the vehicle has an exceptionally large overhang. This feature, which is not uncommon among American cars, probably has been adopted so that the canopy can be swept down gently from front to rear without undue sacrifice of headroom over the occasional rear seats. Because of the gentle slope of the canopy, it has been necessary to incorporate a very deep rear window. In conformity with modern trends, large rear lamp covers of red transparent plastics are fitted.

The styling of the body sides is effective. A large motif is used to break up the plain area of the wing adjacent to the scuttle. Two chromium plated strips, one at the upper and the other at the lower edge of the sill, extend between the wheelarches to accentuate the length of this part of the vehicle, and thus help to balance the large rear overhang. Three horizontal chromium plated strips are mounted over a dummy air intake on each rear quarter panel in front of the wheel.

To break up the large area of the rear quarter panels, a line is pressed in each panel horizontally from the top of the dummy air intake to the rear, and a dummy bumper extension is wrapped round and brought forwards from the main component of the bumper. The crown line of the rear wing is carried forwards over the door handle and then curved down. At the front, an unusual feature is that the side lamps are set in a groove, of semi-circular section, on the wing crown. This groove extends back from just behind the headlamps on each side. The side lamp housing is of elongated streamlined shape and has a chromium plated strip along its crown. It is mounted in the groove and extends back to the scuttle.

CAST CRANKSHAFTS

AMONG the M.I.R.A. Reports that have recently been released for general circulation is No. 1953/1, entitled "Torsional Fatigue Strength of Cast Crankshafts: A Comparison of Four Materials." The report costs 10s. and is available from the Motor Industry Research Association, Lindley, Nr. Nuneaton, Warwickshire.

A fatigue testing machine of the near-resonance type was used for the tests, which were carried out on crankshaft specimens of chrome-molybdenum alloy iron, low alloy inoculated iron, pearlitic malleable iron, and graphitic cast steel. These four materials were found to have tensile strengths of 22, 26, 33 and 51 ton/in^2 respectively. Their fatigue limits, in the crankshaft specimens, were found to be $\pm 4{\cdot}5$, $\pm 5{\cdot}4$, $\pm 4{\cdot}6$ and $\pm 7{\cdot}0$ ton/in^2 respectively. Although the tensile strength of the strongest material, the graphitic cast steel, was twice as great as that of the low alloy inoculated iron, its fatigue strength was only 30 per cent better. These results did not follow the same trend as those of the bending fatigue tests that were carried out earlier on these materials; in these tests, the bending fatigue results were shown to be approximately proportional to the tensile strengths.

The strengths of the crankshafts were compared with those of unnotched parallel specimens of the same cross section as the crank pins. In this way, it was possible, with three of the materials, to assess the degree of stress concentration in the crankshaft specimens. Stress concentration factors of 1·24 and 1·76 were obtained for the chrome-molybdenum alloy iron and the low alloy inoculated iron respectively. However, a figure of 1·53 was obtained for the higher strength, graphitic cast steel; this was lower, by comparison with the other results, than was expected. Further details are given in the Report.

MULTI-POINT RECORDER FOR ROAD TEST WORK

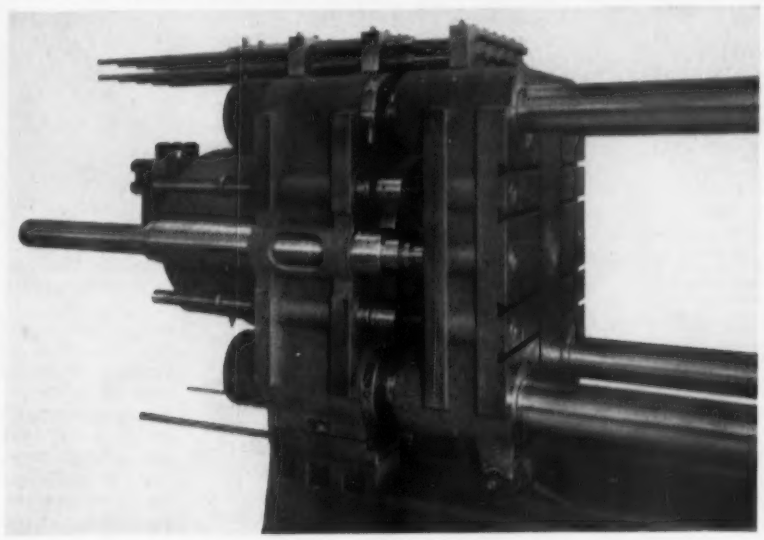
A MULTI-POINT, 12 in wide strip chart, recorder for measurement and recording of temperatures in vehicles under road test is now being produced in the Scottish factory of Honeywell-Brown Ltd. It is based on the continuous balance principle, and is constructed so that it is not affected by vibration, acceleration or deceleration. The instrument provides rapidly accurate information on such things as bearing, rear axle, and brake lining temperatures. It can also be used for testing the efficiency of car heaters.

A unit is at present being used by the road test department laboratories of one of the largest motor manufacturing companies in this country. It is a 16-Point Multiple Record instrument. This particular model has a print wheel speed that gives full scale travel in 2½ seconds and the printing speed is such that the points are switched every 2½ seconds. The calibrated accuracy is within $\pm \frac{1}{4}$ per cent of the scale span, and the sensitivity is ¼ per cent of the scale span. This model has a basic chart speed of 15 in per hour; with change gears, 30 in, 45 in or 60 in per hour can be obtained, as required. Various other models are available and further details can be supplied by Honeywell-Brown Ltd., of Greenford.

TRIULZI DIE-CASTING MACHINES

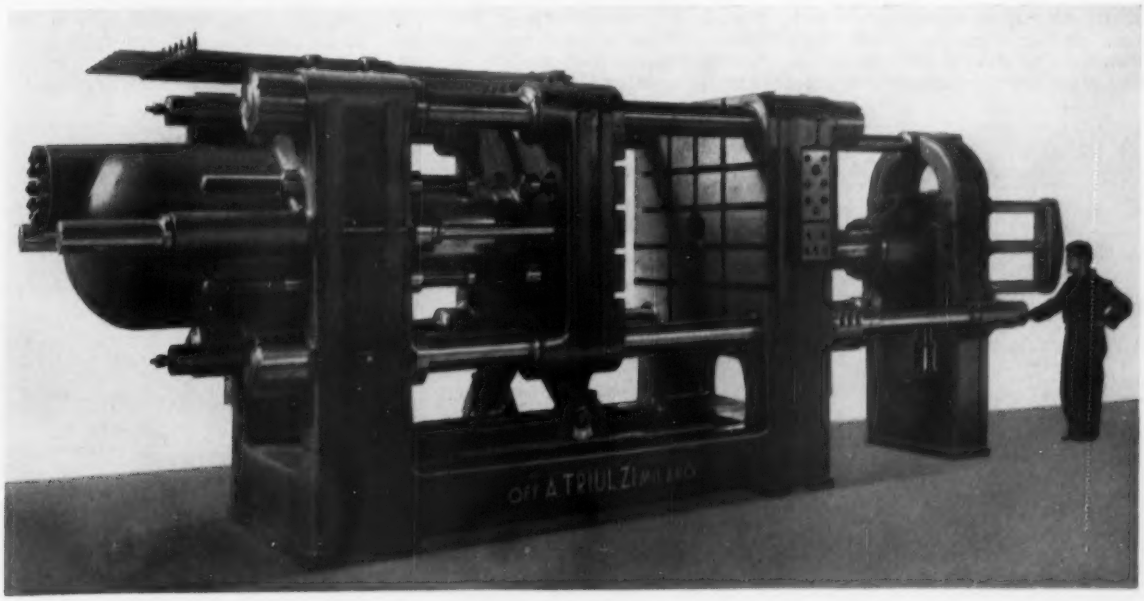
A Range of Cold-chamber Units of the Direct Piston Lock Type

WHILE the use of die-cast aluminium parts is extending in the motor industry, it has tended to be limited to relatively small components, individually of a few pounds in weight. Larger items, requiring much higher injection and locking pressures, can be produced only on massive equipment which, in many instances, must of necessity be specially designed and built. Wider use of relatively larger die-casting machines is made in both America and Europe, where several types of machines are standardized and built in sizes exerting up to 600-ton or 800-ton locking pressure. What is claimed to be the largest standard production machine is the Model 30M, manufactured by A. Triulzi S.R.L., of Milan, which is designed to produce castings in aluminium weighing up to 26 lb each and has a locking pressure of 1,200 metric tons. This is the latest addition to the Triulzi range, previously comprising eight machines having locking pressures of from 28·5 to 750 metric tons. The entire range is handled in this country by Alexander Cardew Limited, 2, 3 and 5 Studio Place, Kinnerton Street, Knightsbridge, London, S.W.1.



Mobile platen of 16M machine in open position, showing mechanical ejection gear, platen push-back rams, and stack of telescopic feeds for hydraulic ejectors and core pullers

The new machine has a total weight of 45 metric tons and its overall dimensions are length 28 ft 6 in, width 5 ft, and height 8 ft 9 in. All main structural members, including the platens, are of cast steel and the four tie bars are 8 in diameter. Parallelism of the fixed and mobile platens is by adjustment of the tie bar nuts and lock nuts. These are of the split type to facilitate the withdrawal of a single bar when necessary to admit an exceptionally large die or when the bronze bushes of the mobile platen need to be renewed. Tie bars and other parts subjected to movement, such as the cast iron pistons, are hard chrome plated and ground to close limits. The platens measure 58 in × 65 in, with a useful space between the tie bars of 58 in × 43·5 in, and the minimum size of die plates to be used is 36 in × 36 in × 6 in. A maximum clearance between the platens of 65 in is possible and the full working stroke of the mobile platen is 39·5 in.



The largest Triulzi machine, Model 30M, exerts a locking force of 1,200 metric tons

Engine cylinder and crankcase, incorporating a cast iron liner. Total weight 9 lb

Characteristic of all the Triulzi machines, the direct ram operating system is claimed to possess several advantages over the toggle linkage system used for locking on certain machines. Die sets of different thickness can be accommodated without the need for adjustment; expansion of the machine and the platens owing to heating-up and to pressure in operation is automatically compensated; although the tie bars are under high stress as a result of the closing pressure before injection takes place, any subsequent elongation of the bars will not affect the closure of the die; and a constant opening pressure over the whole travel of the platen greatly facilitates mechanical ejection of the casting. The mobile platen, carrying a heavy half-die, is supported on wheels running on tracks on the bedplate to accommodate freely such compensating movements. An eccentric mounting arrangement enables the wheel height to be adjusted and scrapers and brushes on the wheel enclosures keep the guides clear of dirt and debris.

The machine is hydraulically actuated with water, selected to ensure rapid operation as its fluidity and low viscosity ensure the minimum inertia, as the operating medium. This is supplied at a pressure of 2,130 lb/in^2 by a feed plant, either individual or a central plant serving a battery of machines, comprising a horizontal ram-type pump and an air-loaded accumulator. For the 30M machine the individual set consists of a pump driven by a 51 h.p. motor and having a delivery of 26·5 gal/min and an accumulator of 220 gal capacity. Water consumption per shot is 21·5 gal. Prefilling is by means of a low-pressure centrifugal pump. A pressure booster, mounted on the machine below the main pressure cylinder, automatically increases the pressure to 4,980 lb/in^2 just before the shot is made. Thus it is ensured that the rated locking pressure is effective and there is no risk of the dies being parted under injection pressure. An interlock device makes it impossible for injection to be made until the boost pressure is applied. The large capacity accumulator (220 gal) provides a more than adequate reserve of pressure water.

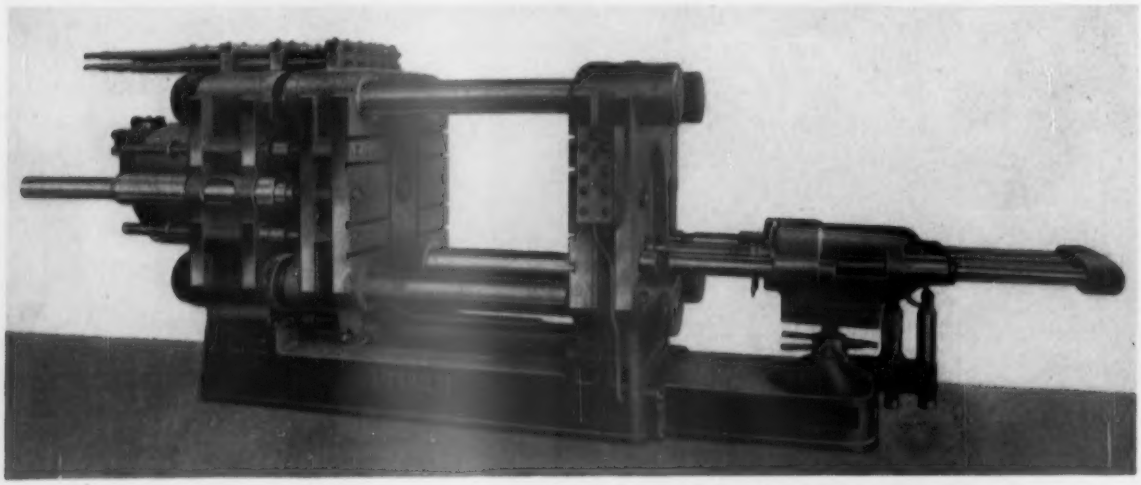
Four injection positions are provided in the rigid platen. The central position is generally suitable for multiple dies and one or other of the lower positions for large single-cavity dies. A change from one position to another is effected by a screw jack; the injection cylinder being slidable in vertical guides in a support frame tied to the main structure by three bars. Water supply to the cylinder is maintained by means of telescoping tubes. Rated injection pressure is 82·8 metric tons.

The chamber into which the molten metal is poured, termed the cold sleeve, is of nitrided steel and the injection piston is of cast iron. Coolant can be circulated through the piston

Shoe for 17 in diameter brake for Fiat 10-ton Orione OM truck. Weight 9 lb

rod. Sleeves of different diameters can be used, thus modifying the capacity of the machine and the pressure on the metal. Fourteen standard sleeves are available, ranging from 90 to 155 mm diameter in steps of 5 mm, and giving, respectively, metal capacities from 202 to 600 in^3 and pressures on the metal from 18,460 to 6,106 lb/in^2 on castings having frontal moulding areas of from 145 to 438 in^2.

Current practice is to estimate, drawing upon prior experience, the pressure needed to cast a particular shape successfully, ascertain the projected area of the casting, and then by relating these two factors to select the size of the sleeve or even the most suitable size of machine to be employed. Since die-cast components are usually produced with minimum practical metal thickness, the weight of the casting is of minor significance. Locking pressure, however, is of the utmost importance as, given a specific



Model 16M machine, locking force 750 metric tons, has a clear space of 43·25 in × 33 in between the tie bars

injection pressure, it determines the surface area that can be cast on a given machine.

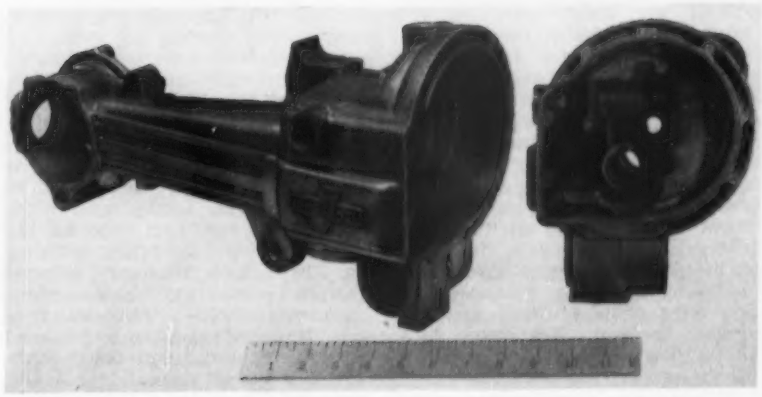
Both mechanical and hydraulic ejection systems are provided. Four mechanical, spring-retracted ejector plungers, slidable in bushes in the mobile platen, are actuated by stops adjustably mounted in the fixed head of the machine as the mobile platen is returned to the open position. A single hydraulic ejector, located at the centre of the mobile platen and fed with pressure water by two telescopic tubes, can be operated automatically at the opening of the platen or by a push-button control. Throughout the opening movement of the platen a constant force, up to 38 tons in the 30M machine, is exerted.

Machines are operated by electro-hydraulic distributors controlled by push buttons; the electric equipment making possible individual control of each operation or, by the inclusion of a timer, a semi-automatic operational cycle. With machines of this size it is essential to effect locking and injection by independent push buttons. A timer can then be used to determine the dwell period, withdrawal of cores, opening, and ejection. The hydraulic valves are motorized and limit switches and hydraulic stop valves prevent the commencement of one operation before the previous operation is completed. A common operating sequence is:

1. Locking by push button. The platens are clamped under a water pressure of 2,130 lb/in^2. Should the dies be too thin, or should the machine inadvertently be operated without dies, a mechanically actuated limit valve automatically by-passes the flow of pressure water to the storage tank and arrests the mobile platen at a predetermined distance, say 30 in to 26 in, from the fixed platen.
2. Molten metal is poured into the cold sleeve.
3. Shot by push button. This is effected in two stages. First the water pressure in the clamping cylinder is raised to 4,980 lb/in^2 and secondly the inlet to the injection cylinder is opened. A safety device ensures that the shot is not made until the lock pressure has risen.
4. Platen opens by push button.
5. After ejection of the slug, the injection piston is automatically returned to starting position by the actuation of a limit switch on the mobile platen.

Semi-automatic operation is arranged with safety devices to ensure correct sequence and duration of operations, including central or lateral hydraulic ejection of the casting.

Optional equipment is available to extend the capacity of the machine, particularly to handle exceptional work. A shot speed adjuster is a control device that varies the speed of the injection plunger during its working stroke. It ensures an initial slow-speed movement, during which air can escape from the die, and then a rapid acceleration to the desired stroke speed, which is pre-set by adjustment of the control valve.

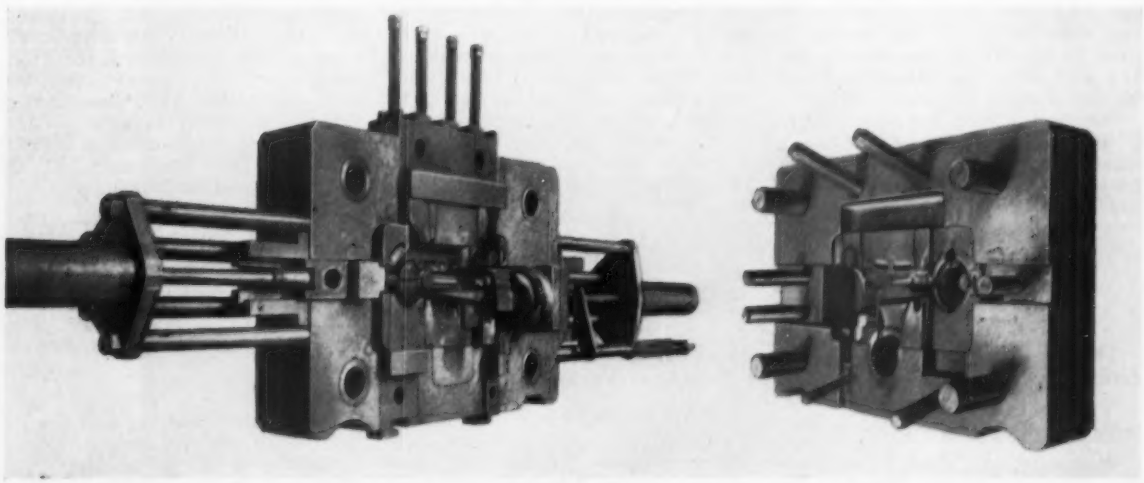


Rear wheel suspension arm for Lambretta scooter. This intricately cored casting is approximately 19 in long

Certain dies incorporating large cores may necessitate lateral ejection of the casting. Usually it is accomplished by hydraulic core-pullers and ejection plungers operated by the machine's pressure feed water. This is transferred from the main cylinder to the mobile platen by way of telescoping tubes. For a straightforward single ejection, one pair of tubes and a hand lever or a switch-controlled valve will suffice, but when multiple ejection in sequence is desired, additional pairs of telescoping tubes and distributor valves, depending upon the number of cylinders to be operated, will be required.

Although rapid movement of the mobile platen is essential, in order to obtain short cycle times, the risks of slamming together the die halves when closing, and of damaging ejection plungers or the casting when opening, must be avoided. A cam rod attached to the mobile platen actuates a valve at appropriate positions and reduces the flow of pressure water, thus slowing the speed of the platen at the ends of its travel.

The Model 30M machine is a recent introduction, but machines of lower



Die set for producing Lambretta rear wheel suspension arm on 16M machine

capacity are widely used on the Continent. One Italian foundry, Fonderpress, of Bologna, is operating twenty-one Triulzi machines and Zündapp-Werke, manufacturers of motor-cycles and motor scooters in Germany, which last year had eight machines, has now a further sixteen machines and also a number of die sets on order. The examples of castings shown were produced on the Model 16M machine, previously the largest of the Triulzi range. This has a locking force of 750 metric tons, injection force of 58·4 metric tons and opening force of 20·6 metric tons. Useful space on the platens between the tie bars is 43·25 in × 33 in.

Possibly the component of most interest is the rear wheel suspension arm of the Lambretta motor scooter. Overall, its length is approximately 19 in and its weight about 8 lb. Both internally and externally the shape is complex, necessitating side cores and also longitudinal cores of exceptional length from each end of the casting. The finned cylinder and crankcase for a single-cylinder engine, produced in France by Bernard Moteurs for industrial and agricultural applications, has approximate overall dimensions of 11 in × 6 in × 7 in. Incorporated in the casting is a cast iron liner for the cylinder bore and the weight, including the liner, is 9 lb. Of a quite different character is the brake shoe for a heavy commercial vehicle. While this is of relatively simple shape, it is of interest on account of the exceptional thickness of the metal sections. This shoe, weighing 9 lb, is for a 17 in diameter brake and has a face width of 6½ in.

The Triulzi concern possesses extensive facilities for toolmaking and undertakes the production of dies for users of machines of their manufacture. Drawing on its specialized experience in this work, it will build a set of dies, and any necessary auxiliary equipment such as core pullers or hydraulic ejection cylinders, for a particular component. It will then prove the set on a machine similar to that for which it is intended, and deliver to the customer ready for mounting and immediate production.

A typical specimen of this work is the set for the Lambretta wheel suspension arm. This shows the long-stroke core pullers and the five kicker-blocks by which sections of the die are automatically withdrawn, in four different directions, when the dies are parted.

As a further service to purchasers of the machines, the firm will arrange to train operators for a period in their die-casting foundry.

SPRAY ATOMIZATION

A REPORT entitled "Effect of Gas Viscosity on Spray Atomization," Report No. 1954/4, has been made available recently for general distribution by the Motor Industry Research Association, of Lindley, Nr. Nuneaton, Warwickshire. This Report costs 10s. It deals with experiments made with a single-hole atomizer discharging safety-fuel into a vessel containing one of a series of gases chosen to represent a range of gas viscosity. The gases used were hydrogen, carbon dioxide, air and argon. Their viscosities cover a range of from 89×10^6 to 222×10^6 poises.

For one series of experiments, the pressures of the gases were regulated so that the densities were all the same, at 0·076 lb/ft^3, and in another series, the densities were all 0·038 lb/ft^3. In each experiment a small quantity of liquid was injected under conditions such that the gas viscosity was the only variable. A sample of the spray was collected on glass slides coated with magnesium oxide and the droplet sizes were estimated. The results are given in the Report as droplet size frequency curves and also in terms of the Sauter mean diameter.

The investigation has shown that, if the conditions are such that air resistance plays only a small part in the process of disruption, the viscosity of the gas into which a spray is discharged has little effect on the atomization of the spray. Such conditions exist when the jet has a high discharge velocity, when it has a high radial velocity component, or when the viscosity of the liquid is small. Within the limits of this investigation, it has been found that increasing the gas viscosity decreases the mean droplet size, reduces the number of large droplets and increases the number of small droplets. With the plain atomizer used, the droplet size distribution in the spray cross section became more uniform and the spray dispersion improved as the gas viscosity increased.

This work is a sequel to an earlier Report, No. 1953/5, entitled "The Effect of Air Density on Spray Atomization," which is also available at the same price. In this earlier work, sprays were discharged from a single-hole diesel type atomizer fitted into the top of a suitable pressure chamber, and samples of the sprays were collected on slides coated with magnesium oxide. The droplets were counted and their diameters measured. To ensure that complete atomization had been attained before the spray droplets were collected, the slides were placed inside the chamber at a sufficiently large distance from the atomizer. It was also necessary to limit the number of droplets falling on the slides, so that overlapping could be avoided and counting made possible. This was effected by restricting the time of spray discharge on to the slides. An apparatus capable of producing one very short injection at a known mean injection pressure was designed for this purpose.

Tests were made with air pressures of 0, 50, 100, 200, 400 and 600 lb/in^2 (gauge) in the pressure chamber. Values of the mean droplet size and of the non-uniformity factor were calculated for each test, and the detailed data have been presented in the Report as droplet size frequency curves.

It is shown that both the fineness and uniformity of a liquid spray improve with increase in air density, but the rate of this improvement which is represented mainly by a decrease in the size and number of the big droplets in the spray, diminishes at higher air densities. With increase in air density, the minimum size of droplet in the spray is largely unaffected, the maximum size is reduced considerably, and there is less variation in mean droplet size across the spray cross section. Some conclusions were also reached regarding the significance of air density in the atomization process.

INSTITUTION OF MECHANICAL ENGINEERS

Forthcoming Meetings of the Automobile Division

The following meetings will be held during April:—

NORTH-EASTERN CENTRE

Wednesday, 20th April, 7.15 p.m., in the Chemistry Lecture Theatre, The University, Leeds. Address by the Chairman of the Centre, Mr. J. L. Hepworth, B.Sc., M.I.Mech.E.

NORTH-WESTERN CENTRE

Monday, 18th April, 7.15 p.m., in the Offices of Messrs. Leyland Ltd., Manchester. Paper: "Analysis and Interpretation of Service Records," by A. T. Wilford, C.I.Mech.E.

WESTERN CENTRE

Thursday, 28th April, 6.45 p.m., in the Royal Hotel, Bristol. Paper: "Matching a Diesel to Light Road Vehicles," by M. Vulliamy, M.A., A.M.I.Mech.E.

MEASUREMENT OF CUTTING FORCES

Some Investigations by Means of the Mecalix Dynamometer

MAJOR factors in the cost of a given machining operation are the rate of output and the cost of cutting tools. Short serviceable life of tools between regrinds increases tool charges and also slows down production by reason of more frequent stoppages for tool changing. Thus the wear of tools has a double influence on the economic aspect of a machining operation. Any attempt to devise a method by which economical operating conditions could be selected would appear necessarily to be based on measurement of tool life. Such a measurement, however, would be inordinately protracted and, since it would be affected by considerable dispersion, would in all probability require to be repeated several times before a satisfactory average value could be established.

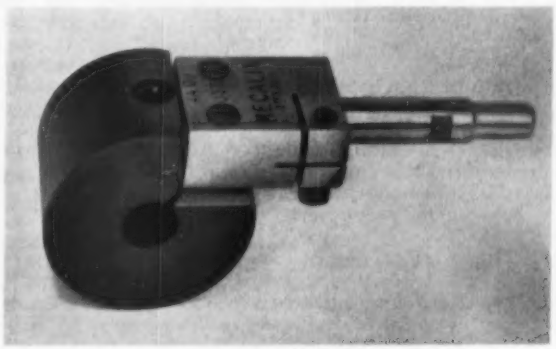


Fig. 1. Standard Type AA Mecalix dynamometer, complete with Solex comparator unit

It would seem possible to reduce the number and the duration of tests if the cutting phenomena in each machining operation were previously analysed. The direct measurement of cutting forces has been adopted by research workers for the investigation of chip formation. In various countries new devices for measuring cutting forces have been developed and have made possible the conduct of research under actual industrial working conditions. In this connection, research in the U.S.A. and in Russia has drawn attention to certain anomalies in the cutting phenomena of several alloy steels.

In France an investigation of the cutting characteristics of various alloy steels has been made by MM. J. Moulin and J. Digard de Cuissart, using the Mecalix dynamometer with a Solex comparator indicating on a suitably scaled standard Solex air controller. As shown in Fig. 3, the transducer body consists of a split ring A of heat-treated silicon steel which is deformed by the load applied through the two steel balls B. Distortion of the ring under load is measured by a Solex 10M comparator unit C securely mounted, normal to a plane containing the axis, on the end of the unstressed free arm D. The high degree of precision of deformation measurements makes it possible to utilize a relatively rigid system having a displacement of not more than 30 microns for the nominal load of 500 kg. Such a rigid system introduced below a tool is not likely to interfere with cutting phenomena. It follows that the measuring head should be able to record with accuracy variations of distances of the order of 0·002 mm. In fact, this type of dynamometer has only attained practical application as a result of modern developments in measuring instruments.

To avoid any change of calibration arising from wear, a small anvil E of tungsten carbide is brazed to the face of the ring for contact by the measuring feeler F of the comparator unit. This unit is connected to a Solex air controller fitted with a scale graduated directly in loading values. By means of flats on its body the unit is screwed into the adaptor G to an approximate zero setting and locked in position by a clamp screw H. The complete unit is compact, robust and practically insensitive to vibration or to temperature changes. By reason of the high limit of elasticity of the steel used for the transducer and the uniform spreading of the stresses imposed, the dynamometer can withstand overloads 400 per cent greater than its nominal load without the calibration being affected. By the addition of a Solex limit switch to the set-up, a servo motor can be controlled from the value of a stress at a given point of a material under investigation or in process.

Measurement of the tangential component of the cutting stress in a turning operation is likely to yield the most practical information for the production engineer. A tool-post instrument, Fig. 5, is available for this purpose; comprising a tool holder that can move only in one plane and is supported on a dynamometer by which the cutting stress is measured. An angular block A, integral with the frame, is clamped to the tool post in the usual manner. Tool bit B is rigidly clamped to a carrier C that can pivot relatively to the frame about a geometrical axis passing through the centres of two self-aligning ball bearings mounted

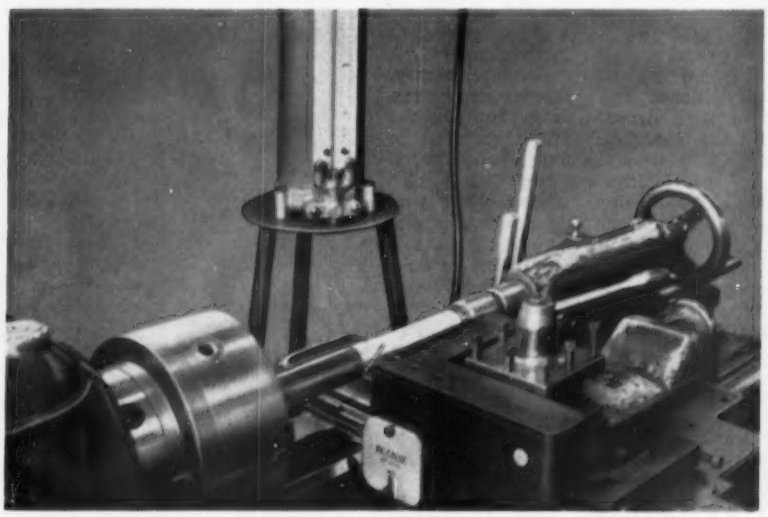


Fig. 2. Set-up of Mecalix dynamometer and Solex measuring equipment for investigation of cutting stresses

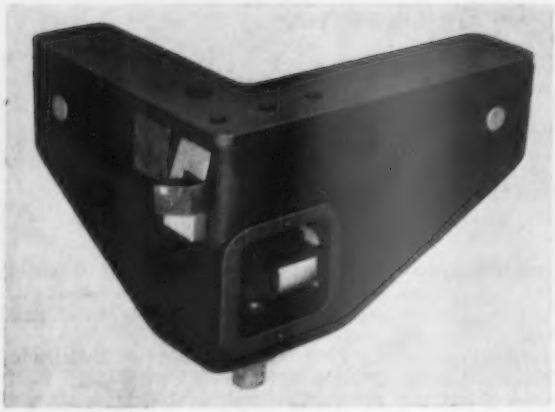


Fig. 4. Special tool-post instrument for measurement of cutting force in turning operations

on shafts D and E. The function of these bearings is to oppose the axial and radial components of the cutting stress, which varies continually and at high frequency about its mean value. Amplitude is small, and under these conditions friction in the bearings is of so low a value that it has virtually no influence on the read value of the stress.

The extremity of the tool is set at a fixed distance from the axis of the dynamometer F and, by means of screw G, the tool tip is adjusted accurately to the height of the axis of the workpiece. A final zero setting of the dynamometer is then effected by adjustment of screw H which preloads carrier C by means of a spring. Since the ratio of the rigidity of transducer to that of the spring is of the order of 5,000 : 1, it may be assumed that this preloading has no effect upon the calibration.

Test conditions

The tests were conducted on a carbon steel and three alloy steels. For each grade of steel three bars were used; one as supplied, one hardened and tempered to an approximate Brinell hardness of 250, and one annealed. Each bar was 90 mm diameter and 400 mm long. Four sets of 16 mm × 16 mm tools with cemented carbide tips were used. Each set comprised four tools differing only in their rake (−10 deg, 0 deg, 10 deg and 20 deg) and otherwise as shown in Fig. 6.

Machining conditions were, in general, held within the following limits:

Depth of cut	..	3·0 mm, constant
Feed	.. ..	0·1-0·5 mm/rev
Cutting speed	..	25-150 m/min

While these conditions are in no way exceptional, a stiffly-built lathe was required for the tests. At a speed of 120 m/min the cutting power consumption exceeded 8 h.p. for a feed of 0·4 mm/rev. The accuracy of the instrument was virtually that of the dynamometer, ±1·0 per cent, but some divergence was possible owing to the difficulty, despite careful determination, of maintaining a constant depth of cut. All the graphs appended relate to tests on a chrome-molybdenum steel, the percentage composition of which is: C 0·18, Si 0·35, Mn 0·70, Cr 0·95, Mo 0·20, P 0·035 and S 0·035.

The tangential component of the cutting stress, or cutting force, is influenced by numerous factors, of which the four following may be regarded as of major importance:

1. Cutting speed.
2. Coolant.

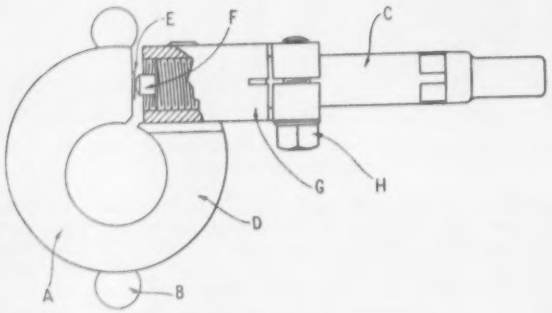


Fig. 3. Arrangement of Type AA dynamometer

3. Character of the work material and its heat treatment.
4. Geometrical features of the cutting tool and the material of which it is made.

The effect of these variables was investigated.

As a preliminary, a comparison was made between the forces required to machine the carbon steel and the chrome-molybdenum steel with carbide-tipped tools of different rake under identical conditions of cut, feed and speed. While the curve representing the variation in the cutting force in function of the rake is normal and continuous—200 kg for 30 deg rake to 300 kg for −10 deg rake—for the carbon steel, that for the chrome-molybdenum steel, Fig. 7, shows an abrupt discontinuity when the tool rake is 10 deg. This manifests itself in a few seconds by a rapid increase in the cutting force to a higher value at which it becomes stabilized. In this zone the dispersion of measured values is considerable, sometimes the increase being as much as 50 per cent. The increase is partly due to swelling of the chip and, if the lathe lacks rigidity, is sometimes accompanied by chatter.

Influence of cutting speed

The behaviour of certain alloy steels in response to variation of cutting speed is markedly different to that of carbon steels, which are not very sensitive to that factor. Fig. 8 shows the test results on hardened and tempered chrome-molybdenum steel. It was noted that the variations in cutting force coincided with morphological variations of the chip. In the curve relating to a feed of 0·3 mm, at a speed below 10 m/min a discontinuous chip requires a cutting force of 335 kg but as speed is increased the chip becomes continuous as a built-up tip is formed and the cutting force falls to 240 kg. It may take several seconds for the built-up tip to develop. At a speed slightly exceeding 15 m/min both the thickness and the temperature of the chip increase and the cutting force rises to a value of 385 kg. Examination of a longitudinal section of the chip shows that in such conditions the upper portion is notched. each variation in the cross-section of the chip corresponds to a variation of the cutting force and manifests itself by leaving an unsatisfactory surface on the work, and often by heavy chatter.

Cemented carbide tool tips are very sensitive to variation of the cutting force and frequently peel when work is performed in the vicinity of these

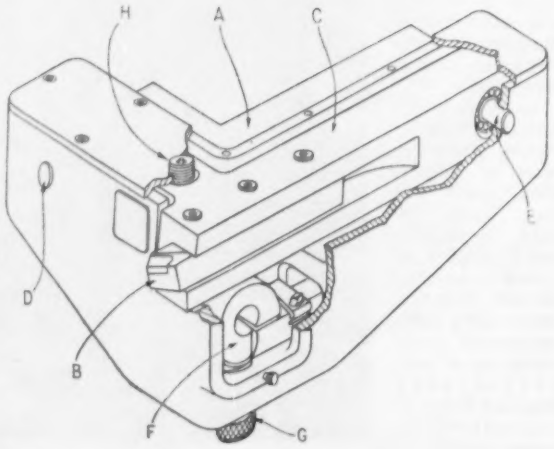


Fig. 5. Arrangement of tool-post instrument

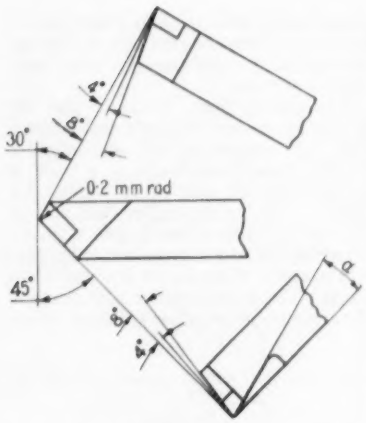


Fig. 6. Form of tool used for tests. Rake angles α were −10 deg, 0 deg, 10 deg, and 20 deg

critical zones. Several tools with a rake of −10 deg peeled when worked in such zones but were quite satisfactory under very much more severe conditions.

A cutting speed of 20 m/min marks the commencement of a pseudo-stable zone in which chip formation is independent of the time element, though it remains sensitive to variation in other factors of machining. The higher the speed the more the phenomenon is stabilized, with a corresponding decrease in the cutting force.

Influence of coolant

A carbide-tipped tool with 10 deg rake working dry on hardened and tempered chrome-molybdenum steel at a cutting speed of 32 m/min has a cutting force of 295 kg. By the use of a coolant, 4 per cent of soluble oil in water, the force is reduced to 204 kg. and the thickness of the chip is also lessened. The initial conditions are restored as soon as the coolant flow is interrupted.

The application of these test results to practical machining operations, in which speeds are determined by the nature of the work, is of interest. It would appear that for speeds above 20 m/min the effect of the coolant is principally confined to cooling action. Within the range of low cutting speeds, however, the lubricating properties of the coolant are very important.

Influence of heat-treatment

Various preliminary investigations into chip formation and structure enabled the following data to be established:

1. During cutting operations the material undergoes transformations very different from those encountered in usual testing methods.

2. The rate of temperature rise is such that a chip can reach 800 deg C within 0·05 sec.

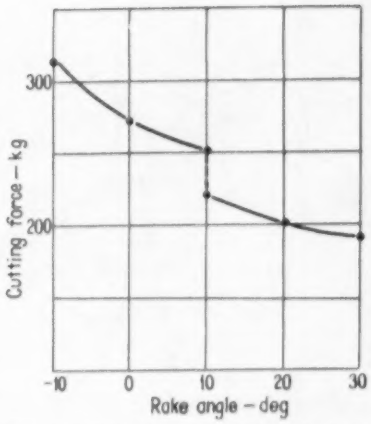
3. Stress frequently exceeds 100 kg/mm².

4. Stressing rate is of the order of 10^5 kg/mm²/sec.

5. Measurement of cross-sections revealed that there is no fixed relationship between compression ratio and cutting force.

While these conclusions do not make it possible to determine the relationship between the material texture after machining and the behaviour of the material during cutting, they indicate that influencing the initial condition of the material offers a means of studying the metallurgical aspects of the phenomena.

In Fig. 9 are plotted the results obtained with chrome-molybdenum steel water-hardened at 850 deg C and tempered at 600 deg C in comparison with those for the same steel in the condition as supplied (annealed 1 hr at 830 deg C and air cooled). It will be noted that from a certain speed onwards approximately similar values of the cutting force are obtained with heat-treated as with annealed steel. The hypothesis is that such a characteristic



Chrome-molybdenum steel, water-hardened 850 deg C, tempered 600 deg C; Cut 3 mm; Feed 0·3 mm; Speed 45 m/min; Carbide-tipped tool

Fig. 7. Cutting force v. tool rake

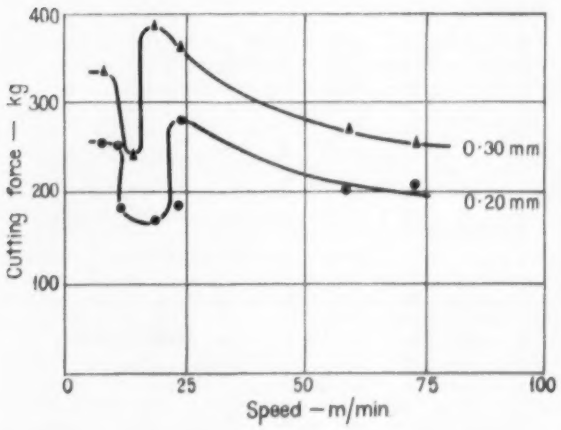
speed corresponds to a textural state of the chip governed by a temperature depending only on the initial texture of the material.

Influence of the tool

Both the material of the tool and its shape modify the cutting phenomenon to some extent. Fig. 10 shows the results of tests made under the same conditions with two tools of the same shape, one of a high speed steel and the other carbide-tipped. In general shape the curves for different feeds are similar but the unstable zones do not occur at the same speeds.

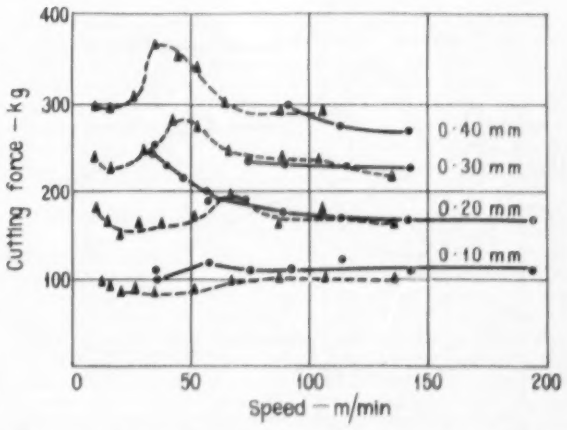
The cutting angle has some influence on the position of the unstable zones and the smaller the angle, the more reduced are the zones. An increase of rake greatly increases fragility of a tool. Under certain conditions the cutting forces are approximately similar for tools with, for example, a rake of −10 deg and 10 deg. In such instances only tools with a zero or a negative rake should be used.

In the dangerous unstable zones the



Chrome-molybdenum steel, water-hardened 850 deg C, tempered 600 deg C; Cut 3 mm; Feed, ▲0·3 mm, ●0·2 mm; Carbide-tipped tool; Rake 10 deg

Fig. 8. Cutting force v. cutting speed



Chrome-molybdenum steel, ▲annealed 1 hr at 830 deg C and air cooled, ● water-hardened 850 deg C, tempered 600 deg C; Cut 3 mm, Feed 0·4, 0·3, 0·2 and 0·1 mm; Carbide-tipped tool; Rake 0 deg

Fig. 9. Comparison of measurements on annealed and heat-treated material

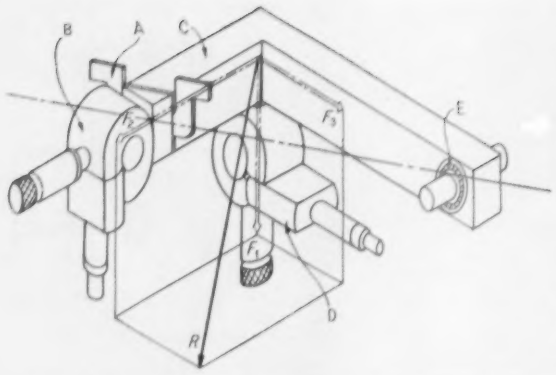


Fig. 13. Diagram of two-directional tool-post instrument

machine tool as well as the work may suffer from the increased loads and from chatter. These conditions occur outside the usual range of application for a carbon steel but may be difficult to avoid in certain alloy steels. However, from a graph embodying test results in which the main factors, feed, speed, and rake, are varied, it is possible to ascertain the conditions under which the work may become dangerous. Such a graph for heat-treated chrome-molybdenum steel is shown in Fig. 11. It has three feeds and four rakes and is rendered more legible by shifting the curves for each tool parallel to the axis of abscissæ. The chain-dotted curve divides the graph into two areas, right and left, in which conditions are likely to produce satisfactory and unsatisfactory results respectively. A fine feed and a pronounced rake are indicated.

When used in a zone of unstable conditions a carbide-tipped tool will in most instances peel off at the cutting edge. This type of tool destruction is essentially different from the usual wear, and is one of the principal reasons for wide variation in the life of a tool between regrinds. By contrast, the wear of a tool used in a zone of stability is consistent and the working life between regrinds can be controlled to regular periods.

Summary of investigation

This study of cutting phenomena by measuring the forces involved resulted in the establishment of four general conclusions:

1. In certain conditions, generally corresponding to large feeds and small values of rake, the cutting phenomena are unstable.

2. Unstable zones are situated between certain speeds which depend on the work material and the tool material.

2. Use of a coolant can attenuate, in certain cases, the dangerous effect of unstable conditions.

4. The influence of heat-treatment on the cutting force is observed only above certain speeds. These probably correspond to a definite cutting temperature.

Other applications

The Mecalix dynamometer can be used, of course, for a wide variety of purposes other than measuring cutting forces in machining operations. By virtue of its compactness, relative rigidity, and precision, it can conveniently be applied in many instances where previously dead-weight instruments were used. It can give precise information of the distortion of machine tools under various loads under actual working conditions. In conjunction with servo-mechanisms it can be permanently embodied in a machine to serve as a pressure-sensitive or dimension-sensitive element for automatic control systems.

For purely static loads it may be preferable to use a simple instrument, Fig. 12, consisting of a triangular flexible plate A anchored to a body B at the ends of one of its sides. Its rigidity is so much smaller than that of the dynamometer that it has virtually no influence on readings, but it opposes components of the forces situated in its plane. The dynamometer C is zeroized by adjustment of screw D which varies

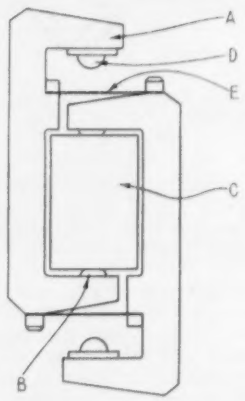
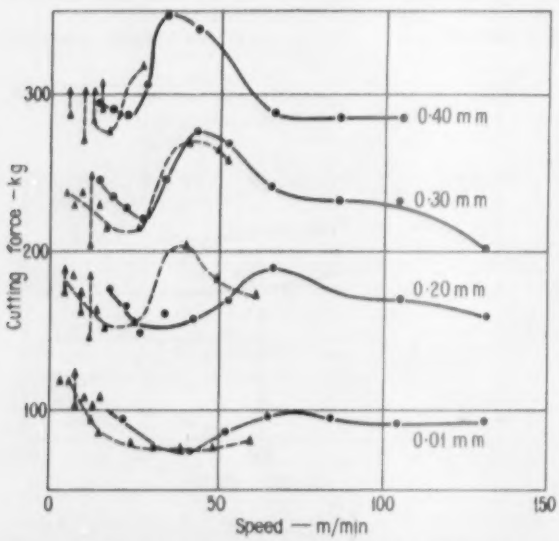


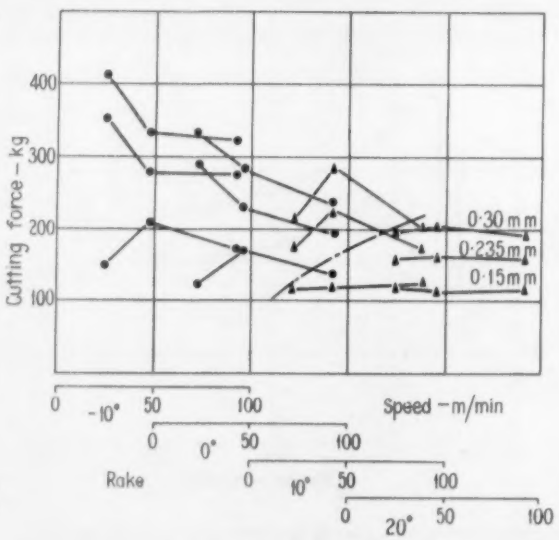
Fig. 15. Adaptor for measurement of tensile stresses

the initial load on the triangular plate. This instrument can be used to measure a compressive force, or one component of such a force, when its direction is known, but is more versatile than the special-purpose tool-post instrument. Typical examples of its application are for measuring or calibrating hydraulic or pneumatic jacks, chucks or clamps, welding machines, presses or shears.



Chrome-molybdenum steel, annealed 1 hr at 830 deg C, and air cooled; Cut 3 mm; Feed 0·4, 0·3, 0·2 and 0·1 mm; ▲H.S.S. tool, ●carbide-tipped tool; Rake 0 deg

Fig. 10. Comparison of results with H.S.S. and carbide-tipped tool



Chrome-molybdenum steel, water-hardened 850 deg C, tempered 600 deg C; Cut 3 mm; Carbide-tipped tool

Fig. 11. Demarcation of stable and unstable machining zones

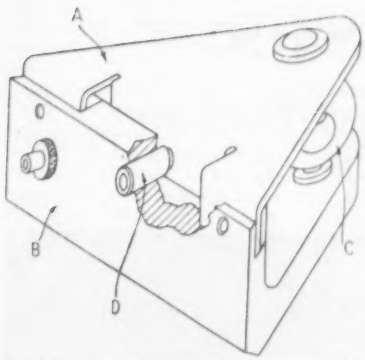


Fig. 12. Arrangement of instrument for measuring static loads

It can also be used for applying given loads to structures, for measuring the distortion of structures or machines under load and the direct measurement of forces in dynamometric brakes.

While the determination of the tangential cutting stress in a turning operation enables the best feed and cutting speed to be selected for economy under practical working conditions, it may be required in a laboratory to investigate the stresses more thoroughly. The tangential and axial components of the cutting stress may be measured with a special two-directional tool-post instrument fitted with two dynamometers. From the diagrammatic arrangement, Fig. 13, it will be seen that it differs but little from the uni-directional instrument, Figs. 4 and 5. A leaf-spring suspension A is substituted for one of the self-aligning bearings and thus the carrier C is permitted a second possible direction of movement. A second dynamometer B measures the component F_2 of the stress R. As in the uni-directional instrument, dynamometer D measures component F_1 and bearing E opposes component F_3.

Apart from their use in the measurement of cutting stresses, instruments of this type are well suited to the measurement of coefficients of friction or to the study of hydrodynamic drags of models in a two-dimensional type of flow.

For the measurement of very heavy loads a modified dynamometer, shown diagrammatically in Fig. 14 and designated type AH, is produced. The transducer is a continuous ring A to which the load is applied through balls B. Ring A is attached to body C at two points so located that distortion of ring A under load is not transmitted to the body. The comparator unit D is mounted co-axially with the body and ring A and its feeler E contacts a tungsten-carbide anvil F brazed on a bowed strip G extending across ring A in the axial plane containing the two balls.

Under load the displacement axially of the anvil F is three or four times greater than the deflection of ring A in the direction of load. The transducer has an outside diameter of 45 mm and is exceptionally rigid; the displacement is only 15 microns under a load of 1,000 kg.

Instruments already described can be used only for measuring compressive forces and when it is desired to investigate tension stresses an adaptor, Fig. 15, is necessary to permit the use of a standard dynamometer. It consists of a pair of C-frames A, inter-engaged to reverse the stress. Each is fitted with a ball B engaging the dynamometer C and a ball D (or alternatively a threaded rod) through which the tension is applied. Slight errors in alignment, as may occur in practice, produce forces

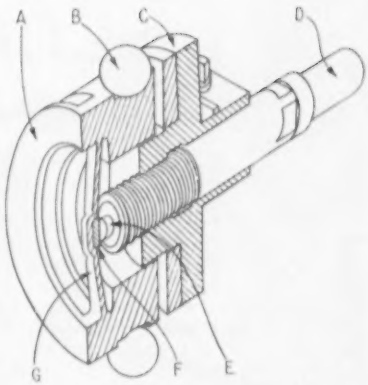


Fig. 14. Type AH dynamometer for heavy load applications

directed in a plane perpendicular to the axis of the tension but these are cancelled out by leaf springs E and do not affect the readings.

Another special application is a combined torque-meter-dynamometer for measuring the torque and thrust occurring during drilling operations. The test piece to be drilled is held in a chuck mounted on a vertical shaft free to rotate and slide axially in two ball bearings. Thrust is measured directly by a dynamometer located beneath the end of the vertical shaft. A second dynamometer is compressed by the free extremity of a radial arm secured to the shaft, in function of the torque exerted by the cutting force.

Mecalix dynamometers and dynamometric instruments are handled in this country by Solex (Gauges) Ltd., 72 Chiswick High Road, London, W.4, the manufacturers of the comparator units and air controllers used in conjunction with the instruments.

OIL CONSUMPTION

REPORT No. 1953/2 has recently been released for general circulation, by the Motor Industry Research Association, of Lindley, Nr. Nuneaton, Warwickshire. The price of this report is 10s. It is entitled "A Note on Oil Consumption in I.C. Engines," and deals with the influence on oil consumption of slight changes in the dimensions of plain rectangular compression rings and slotted and grooved scraper rings. A single-cylinder research engine was used for the work in the laboratories.

It was found that changes in the sizes of the gaps or side clearances of the rings produced no change in oil consumption rate. Any factor, such as geometry of the ring or dish of the groove, that affects the attitude of the compression ring face relative to the cylinder wall has a large influence on oil consumption. This emphasizes the importance of the nature of the path between the ring face and the cylinder wall, so far as the passage of oil up the piston is concerned. If the lower edge of the compression ring bears on the wall, the ring tends to scrape oil downwards and so keep consumption low. On the other hand, rings that bear at their upper edges tend to scrape oil upwards and so greatly increase consumption.

In many instances, square-faced rings have faces that are not true. On the other hand, taper-faced rings always bear on one edge despite manufacturing tolerances. As is to be expected, consistently low oil consumption is obtained when these rings are fitted in such a way that their lower edges bear on the cylinder walls. So strong is the oil control exercised by taper-faced compression rings that it was found possible to run satisfactorily with only one such ring fitted to the piston. In addition, when oil drain holes were furnished, the consumption was the same as when a scraper ring also was fitted. Since there does not appear to be any disadvantage in fitting several taper-faced rings on one piston, it would appear to be better to do this than to risk offsetting the advantages obtained from one taper-faced ring by using a number of inefficient square-faced ones.

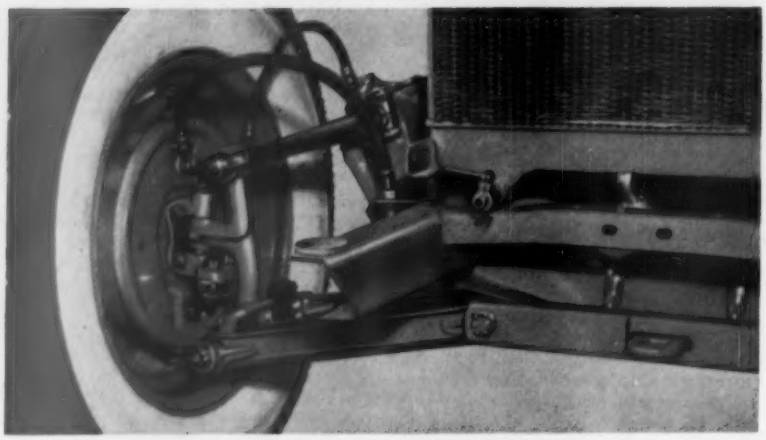
The main conclusions drawn from the work on the single-cylinder research engine were confirmed by endurance running on two conventional multi-cylinder motor car engines at a road load and speed equivalent to 35 m.p.h. This work also showed that the advantage of the taper-faced ring over the square-faced ring, so far as oil control is concerned, was maintained even after deterioration had set in. No observations concerning wear were made during any of these tests.

SKODA 1200 CHASSIS

Some Impressions of the Latest Version of This Unit with a Backbone Type Frame

THERE are few vehicles in which the backbone type of frame is employed. The arrangement has its advantages and disadvantages: generally it facilitates body mounting, particularly when a number of alternative bodies are based on the same chassis. However, unless both the backbone and the outriggers from it are exceptionally stiff, the layout is only suitable for light bodies. To make the main components stiff enough for heavier coachwork involves increasing their cross sectional dimensions and weight, and this is rarely desirable or practicable. Nevertheless, large passenger-carrying coaches have been designed on this principle, but with this type of vehicle it is not too difficult to provide adequate space under the floor for a backbone of very large cross section.

Contrary to a belief that is held in certain quarters, the main difficulty is in obtaining adequate torsional stiffness. Although the central tube basically is stiff torsionally, the body sides are relatively remote from it and therefore the mass moment of inertia of the load to be carried by the frame is large. Probably the greatest proportion of the torsional deflection that takes place is due to bending of the outriggers. For the heavier private cars, it would appear that box section, frame side members positioned approximately beneath the body sides and adequately braced by box section cross members, and with or without a cruciform truss, represents the best arrangement.

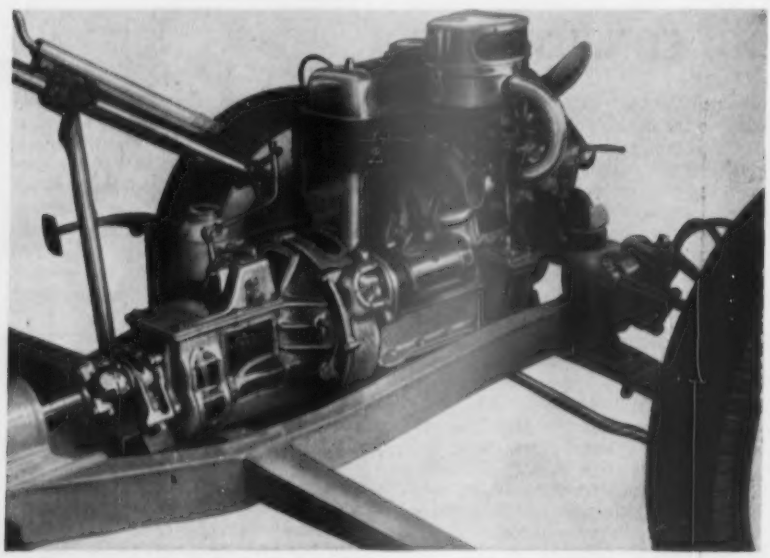


Simple pressed links, together with the leaf spring, form the lower arms of the front suspension

Specification

A four-cylinder, four-stroke engine with push rod operated overhead valves is installed in the Skoda 1200. Its bore and stroke are 72 mm and 75 mm respectively and the swept volume is 1,221 cm^3. The compression ratio is 6·5:1; this, of course, is low by modern standards. The maximum power output is 36 b.h.p. A conventional water cooling arrangement, with a centrifugal type pump, is employed, and a thermostat is incorporated in the system. In the four-speed gearbox only third and fourth speeds are synchronized. A single dry plate clutch is interposed between the engine and the gearbox.

The principal dimensions of the vehicle are as follows. Its wheelbase is 8 ft 8¼ in. At the front, the track is 4 ft 1¼ in, and at the rear it is 4 ft 4 in. It is stated by the manufacturers that the ground clearance is 7½ in. On the private car, 5·50—16 tyres are fitted, and on the station wagon and van, 6·00—16 tyres are employed. The overall length of the car is 14 ft 9 in and of the station wagon and van 14 ft 3½ in. So far as width and height are concerned, the overall dimensions of the car are 5 ft 6 in and 5 ft respectively, those of station wagon are 5 ft 6½ in and 5 ft 2½ in, and of the van they are 5 ft 6½ in and 5 ft 6 in. The weights of the car, station wagon and van are 2,200 lb, 2,380 lb and 2,310 lb respectively.



An unusual feature of the engine is that the oil filter is housed in a cell cored in the crankcase casting

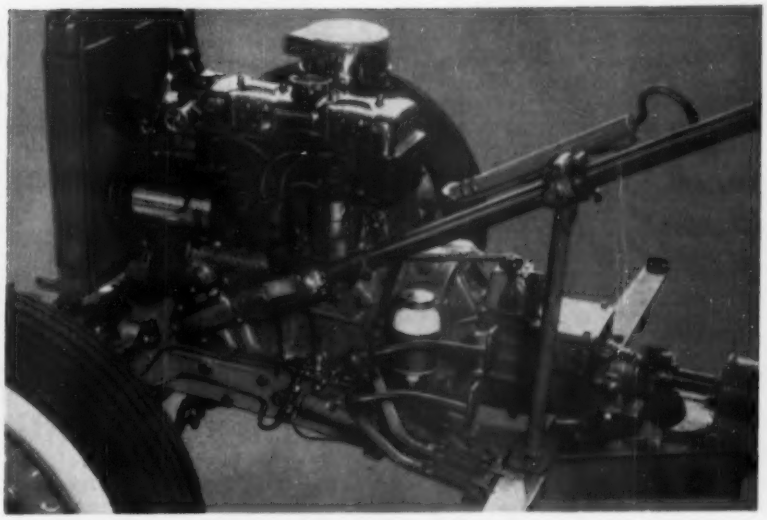
General arrangement

At the centre, the axis of the tubular backbone is about 18 in above the ground. The rear end of the tube is flanged, and the final drive unit is bolted to it. Towards the front, immediately behind the gearbox, the tube is terminated and a fork extension is welded under it. The arms of the fork pass forwards on each side of the gearbox and engine unit. They are of box section formed by two channels with closing plates welded between the edges of their flanges. Immediately behind the suspension cross member, the cross section of

each arm of the fork is 1¼ in wide by 3½ in deep. Where the arms join, at the rear, they are 2½ in wide by 3¼ in deep.

A socket of heavy construction forms the junction between the fork and the tube. The end of the tube is welded in the socket, the flat base of which is welded on top of the fork extension. A tie plate is fitted between the lower edge of the fork member and the tube behind the socket. A cross member is welded between the arms of the fork, where they are bent to pass parallel on each side of the engine. Another cross member is fitted between the front suspension units. Immediately in front of it, there is yet another that helps to support the radiator; the rubber mountings for the radiator are, in fact, on the side members immediately outboard of the ends of this cross member. Forward of this point, the closing plates between the flanges of the arms of the fork terminate; so the extreme front ends of the arms, each of which carries a body mounting point, are of simple channel section.

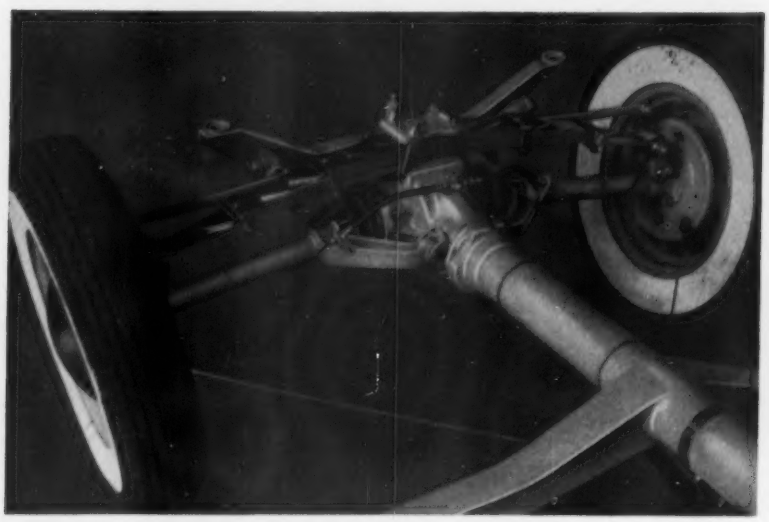
Two pairs of transverse outrigger arms are fitted to the frame. One is welded on the tube immediately in front of the rear wheels, and the other is attached to the fork extension at a point behind the front wheels, where it forms lateral extensions of the rearmost cross member between the arms of the fork. This member passes under the gearbox and carries the rubber sandwich type rear mounting. On the end of each outrigger is a small dished pressing to receive a body mounting. At the extreme rear end, another small cross member is bolted on the back of the final drive casing. This member has dished pressings welded on each end to receive the body mountings. It also carries the bolted-on, lever type hydraulic shock absorbers.



The distributor valve for the chassis lubrication system is mounted on the side frame forward of the pedals

The engine is carried on a three-point mounting. At the front there is a circular double-sandwich type unit on each side. It is interposed between a bracket welded to the front plate of the engine and a platform welded on top of the frame side member at each end of the suspension cross member. The rear mounting is an exceptionally large rubber sandwich unit. It is 1⅛ in thick by 5 in overall width, and the rubber projects from the centre of its rear face to form a 1½ in thick by 2½ in wide rearward extension. The top plate of the unit is turned down behind this extension to prevent forward motion of the engine and gearbox unit under clutch pedal loads. Apparently there is no need for a similar stop in front of the mounting.

An engine layout of conventional form has been adopted. A deep-skirted, aluminium alloy crankcase is employed and the wet liners have shoulders round their lower ends to seat on a sealing ring on the lower deck of the casting. This deck is exceptionally thick, ⅜ in, to provide adequate support for the liners. The valves are in line in the head and are set at a small angle from the vertical. They are push rod operated in the normal manner from a low camshaft. An unusual feature is that the oil filter is carried in a cell cored in the right-hand side of the crankcase casting. The cast aluminium alloy sump is finned.



The final drive casing is bolted to a flange round the rear end of the tubular backbone of the frame

The universal and sliding joints of the propeller shaft are immediately behind the gearbox, where they are in an accessible position. The shaft is taken to the rear, through the tubular backbone, to the final drive casing. Thence the drive is taken through the swing axles to the hubs. Forged fork-ends are welded to the axle tubes. The arms of the forks pass one in front and the other behind the universal joint, which is protected by a rubber gaiter. Their ends are fitted with rubber bushed pivot bearings. These pivots are each carried between a pair of lugs of a U-bracket bolted to the final drive casing.

The transverse leaf spring is 2¼ in wide and has nine leaves. It is mounted on top of the final drive casing and is connected to the ends of the axle tubes by shackles. Another shackle is fitted on each side, between the pin in the spring eye and the lever arm of the shock absorber. Rubber bushes are employed in the spring eyes.

At the front end of the vehicle, a transverse leaf spring is again used. It is 2½ in wide and has seven leaves. The spring takes only the drag and vertical loads on the lower arm of the transverse link suspension system. It is used in conjunction with a single link at each side; these links provide positive lateral location of the wheel hubs. The upper links are of the wish-

bone type. They form the arms of the shock absorbers, which are mounted on the platforms, already described, that carry the front mountings of the engine.

A noteworthy feature of the chassis is the lubrication system. Operation of a kick-down plunger on the toe-board lubricates all the main pivot points on the chassis. A distributor valve is mounted on the frame in front of the pedals. From it, one pipe goes to each front suspension unit, one to the lower bearing in the steering box and another to the pedal pivots. Yet another pipe is taken to the centre of the backbone tube to lubricate the transmission at the rear end.

As can be seen from the illustrations, the layout of the pipe lines is exceptionally simple. On the front suspension, the first connection is to the shock absorber casting to lubricate the bushes that take the loads of the upper wishbone. Thence a pipe is taken to the outer bearing of the upper wishbone, from where another pipe is connected to the swivel pin knuckle. The pipe connections are so arranged that the lubricant flow is straight through, and the individual leads to each bearing are branches off this main gallery. Thus, there is little chance that a blockage of a duct to any one of the bearings will lead to starvation of other parts of the system. In the event of the flow through one of the bearings being excessive, it is possible for the remainder of the system to be starved. However, it is unlikely that excessive leakage would remain undiscovered for long. Rubber bushes are employed for the bearings of the lower links and in the spring eyes.

THE ELGRO GEAR BRUSHER

A Production Machine for Automatically Deburring Gears after Hobbing

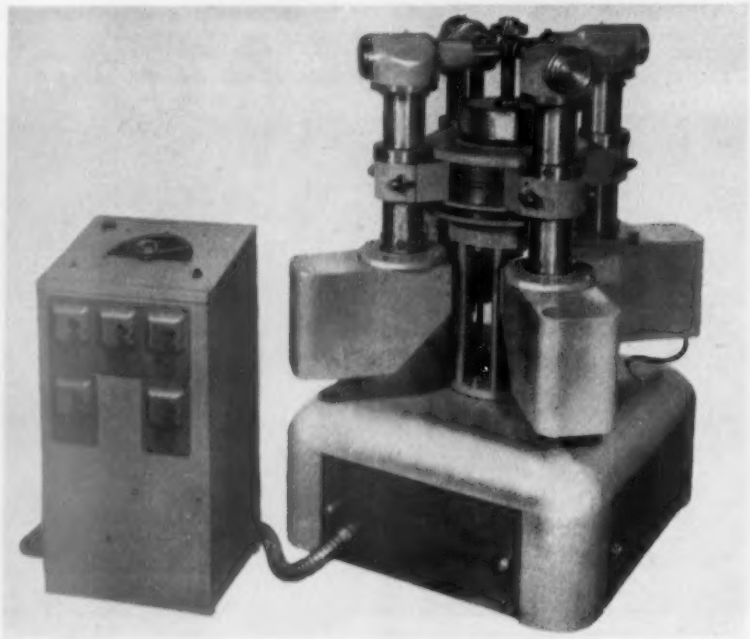
As gears leave the hobbing machine they invariably carry substantial burrs on the tooth form on one face and, before they can be passed on for subsequent operations to be performed, it is necessary to remove these burrs. Commonly this is effected by means of hand filing or hand grinding, requiring a certain amount of skill and care and a considerable expenditure of time. The Elgro brushing machine can eliminate all hand labour and clean the gears automatically without any risk of damage to tooth flanks or crowns. If inserted in the production line, the machine can contribute to its efficiency and economy by eradicating a discontinuity. Requiring only unskilled labour to operate the simple loading and unloading and press-button starting and stopping, the cycle time for an automobile transmission gear is in the region of 30 to 40 sec.

The machine consists of a central column around which are mounted, adjustable for height, radial position, and angularity, four or more brushing heads. Each spindle is driven by a separate variable-speed motor through a rubber belt, a vertical shaft, and bevel gears at about twice the motor speed. The main spindle in the central column is driven from a motor enclosed in the machine base and imparts to the work spindle a planetary motion about the main axis. This spindle carries a toothed adaptor, determined from the number of teeth in the work and the number of brushing heads employed, which operates in conjunction with pawls in the column head, to index the work progressively one tooth for each planetary rotation. Thus, as the main spindle rotates, the work is fed towards each of the fixed-location rotating wire brushes in turn.

To mount the work so that the tooth spaces align correctly with the brushes, the gear is placed over a mandrel at the head of the work spindle, positioned radially by a pivoted latch engaging one of the tooth spaces, and clamped by hydraulically operated internal plungers. Thus secured, the work spindle is lowered hydraulically to bring the gear into contact with the brushes. At the conclusion of the predetermined cycle the work spindle is automatically raised to lift the work clear of the brushes and the clamp is released. Cycle time can be adjusted to provide any number of spindle rotations up to 25, as required to ensure completely clean work.

A standard machine can handle gears up to 2 ft diameter. For the largest sizes the brushing heads are turned out about their vertical drive axes and larger diameter brushes are used. Up to eight brushing heads can be used if required on the larger gears in order to reduce cycle times. The machine illustrated is actuated by six electric motors, to an aggregate of about 2 h.p. Four are required for the brushing heads, one for the main spindle and one for the hydraulic pump. Working life of the wire brushes cannot be stated precisely since it will vary according to the work material specification and the character of the burr to be removed. Provisionally it could be taken as from 4 to 6 hr in continuous operation. Providing the difference in the diameters of adjacent gears in a cluster is not too wide, it is possible, by the use of special brushes of reduced width, to debur the two gears simultaneously.

The makers of the machine are the Elgro Machine Tool Co. Ltd., a subsidiary company of Gem Brushes (Luson) Ltd., Minerva Road, Park Royal, London, N.W.10.



The Elgro brushing machine for deburring hobbed gears

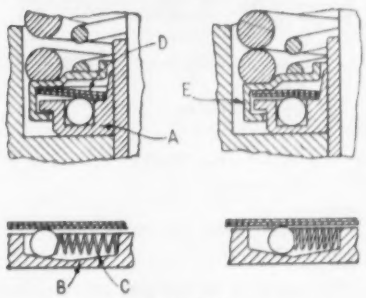
CURRENT PATENTS

A Review of Recent Automobile Specifications

Valve rotator

THIS valve rotating device, which can be assembled to give either right- or left-hand rotation to suit the coiling of the main valve spring, is produced and fitted as a self-contained unit. The retainer A is formed with six arcuate grooves, each having a base B inclined from the ends to a lower central point. Each groove accommodates a ball biased towards one end by a spring C. One or more Belleville spring washers D are seated on the upper face of retainer A and engaged by the valve spring seating collar E.

The sections on the left show the disposition of the parts when the valve is seated, the valve spring load being insufficient to deflect washers D. When the valve is lifted from its seat the load is increased beyond the flexing point of washers D, which are then bowed to bear heavily on the balls. The transfer of the load to the balls causes them to roll against the constraint of springs C and towards the deeper central portions of the grooves, as shown in the right-hand sections. Since washers D are frictionally held in engagement with collar E and only



No. 710512

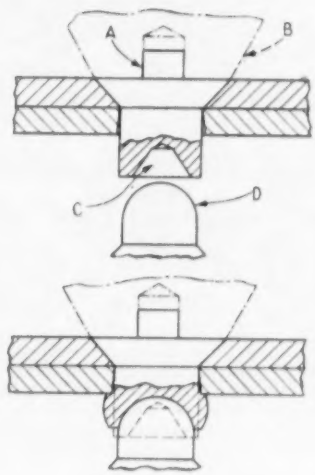
loosely engaged over the spigot of retainer A, the valve will be progressively rotated. By a reversal of the positions of the ball and spring in each groove, the valve will be caused to move in the opposite direction. *Patent No.* 710512. *Thompson Products, Inc* (*U.S.A.*).

Riveting system

PARTICULARLY, but not exclusively, intended for aircraft construction, this flush riveting system requires less than the usual force to set, does not damage or deform sheet-metal work, and gives a fluid-tight assembly. The elements of the system are a rivet with a recessed shank, a dolly with a face the same diameter as the rivet head, and a set with a hemispherically shaped end.

The rivet has a countersunk head with a cylindrical centering projection A to locate the dolly B. In the end of the rivet shank is a conical recess C; the major diameter of the recess is about 60 per cent of the shank diameter and the apex angle is about 70 deg. The diameter of the end D of the set is about 30 per cent greater than the diameter of the recess.

Given a rivet of a length appropriate to the work, the set expands the hollow



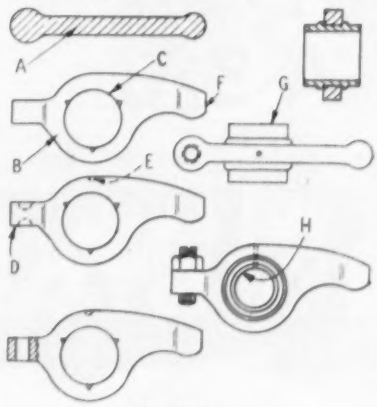
No. 712305

portion of the shank to form a head and the maximum expansion occurs in the immediate vicinity of the work. At the same time a thrust is exerted, tending to clamp the workpieces tightly together and to expand the solid part of the shank to fill the hole in the work.

The system is applicable to steel rivets and in most cases it makes cold riveting possible. *Patent No.* 712305. *Avions Hurel-Dubois* (*France*).

Fabricated valve rocker arm

BY this method of construction, it is claimed, the specific advantages of the forged and the stamped sheet metal rocker are combined and, since welding and brazing are eliminated, none of the desirable qualities of sheet or plate metal are lost. The material for the arm is a preformed plate metal strip A having a flat mid-section and bulbous margins. In the first operation the blank B is stamped from the strip and simultaneously hole C is pierced and notched at three points on each of its edges. Next, aligned indentations are pressed in the bulb end D and a smaller indentation E is formed in the edge of the



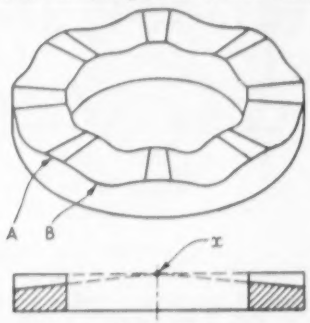
No. 711123

blank above hole C. End D is then pierced and subsequently threaded to receive the adjuster screw. The profiled lower face of bulb end F is locally hardened by heating with a gas flame and quenching in oil or water.

A tubular member G of predetermined length is inserted in hole C and upset on both sides of the arm by pressure applied to both ends while the ends and the bore are confined. The metal flows to form upset annular flanges, axially locating the tubular hub, and into the notches in the edges of hole C to prevent relative rotation. After pressing in a bearing bush H an oil passageway is drilled from indentation E through arm, hub and bush. *Patent No.* 711123. *J. M. Leake* (*U.S.A.*).

Thrust washers

WHILE full fluid lubrication is promoted in a journal bearing by the wedging action resulting from the eccentric position assumed by the journal, no such influence operates in thrust bearings having plane surfaces. It has been proposed to form a thrust-bearing element with an undulating circumferential surface



No. 711075

to overcome this disadvantage and the present invention relates to such profiled thrust washers.

Preferably the washer is of bi-metallic structure, having a backing of steel or other relatively strong metal and a facing of a bearing alloy. For washers of from 1 in to 3 in bore the initial thickness of the bi-metal may be 0·091-0·092 in and the radial width from 0·187 in to 0·312 in. At all radii from the axis the bearing face has a sinusoidal wave formation, the wave length being from one-eighth to one-fourth of the circumference. The crests of the waves are truncated to provide flat faces A, each extending over an angle of about 5·6 deg, in a common plane normal to the axis. From point *x*, where that plane intersects the axis, straight lines having an inclination from the plane of 0·001 in per inch radius define the valleys B of the wave formation.

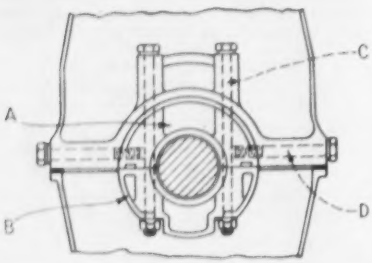
It is proposed to produce the washer by heating the blank to about 150 deg C and impressing the profile in the bearing surface by a hard metal die. One circular die can be used to form washers of a range of sizes with a profile of constant wave length, in terms of diameter, and of constant truncation of crests, in terms of wave length. *Patent No.* 711075. *Glacier Metal Co. Ltd.*

Mounting main bearings in light alloy crankcases

OWING to the difference in the coefficients of thermal expansion of a steel crankshaft and a light alloy crankcase, variation of the designed running clearance of main bearings fitted directly into the case will occur with changes of operating temperature. It is proposed, therefore, to mount the bearing shells in substantial, two-part bearers of a metal having the same or an approximately similar coefficient of expansion as the crankshaft.

The illustration shows the arrangement in a crankcase divided in a plane containing the axis of the crankshaft. Upper and lower halves A and B of the bearer are clamped together and to the crankcase or engine block by the vertical bolts C. Horizontal set bolts D passing through bosses at the base of the crankcase partition engage half A and brace the assembly transversely.

For a barrel-type crankcase the bearer halves A and B are pre-assembled on the crankshaft (in a manner not specified) and after the shaft has been threaded into position horizontal bolts are screwed in from the sides and vertical bolts from below through the sump aperture. The construction is not limited to line-type



No. 712307

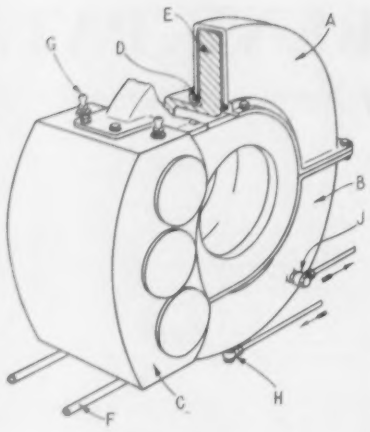
engines. It may be employed in a V-type engine and, if the camshaft is positioned at low level between the banks of cylinders, divided camshaft bearings may simultaneously be secured by the vertical anchor bolts. *Patent No.* 712307. *Bayerische Motoren Werke A.G.* (*Germany*).

Fluid-cooled disc brake

IN an earlier patent, No. 693919, a disc brake was enclosed in a thin casing of a metal of high thermal conductivity to prevent the fouling of the disc by mud or road grit. This invention constitutes a modification to improve the cooling of the brake.

The casing is formed in halves A and B flanged and bolted together and to the caliper-type brake housing C. Each half at its inner periphery is recessed to accommodate a sealing ring D which maintains a fluid-tight contact with the inner periphery of the brake disc E. To facilitate bleeding of the brake cylinder the caliper housing is arranged horizontally, with inlet connections F from the master cylinder at the lower side and bleed vents G at the top.

Lubricating oil delivered by the engine pump is admitted to the casing at inlet H and is returned to the engine sump from outlet J arranged about half the radial width of the brake disc higher. Alternatively, a separate cooling system may



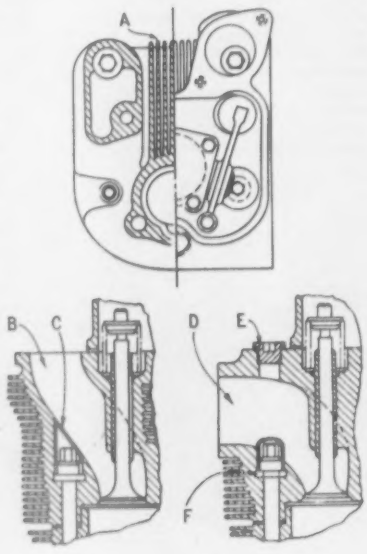
No. 711059

be provided. A pump driven from the vehicle transmission may be used to circulate a supply of glycol or similar fluid through the casing. *Patent No.* 711059. *Dunlop Rubber Co. Ltd.*

Air-cooled cylinder head

AS a consequence of the congestion of valve ports, overhead valve gear, push rods and holding down bolts, difficulty is commonly experienced in providing adequate cooling for the cylinder head of an air-cooled diesel engine. The most difficult portion of the head to cool is the bridge between the two valve seatings and the problem is likely to be accentuated if the engine has a precombustion chamber or a swirl chamber offset from the main combustion space in the cylinder.

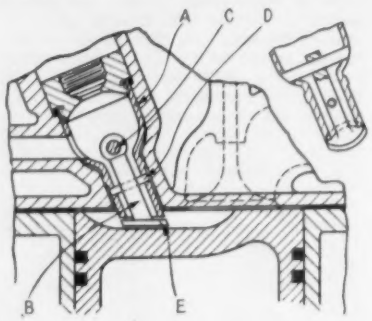
By arranging for the axes of some of the securing bolts to intersect the inlet and exhaust passages, more space is made available for finning and a less interrupted flow of air across the head can be obtained, it is claimed. In the embodiment shown, the bolts, which extend down to the crankcase, are uniformly spaced around the cylinder and the passages diverge from the



No. 710563

cylinder axis to allow more fins A to be provided. It is of advantage for the passages to lead to the exterior of the head in the direction of the bolt axis, as shown in the inlet passage B, so that the nut is accessible when the manifold has been removed. To avoid any interference of the air or gas flow the nut is accommodated in a recess which is closed by a cap C secured either by fit in the recess or by a lock screw from the exterior.

If the passage communicates laterally with the exterior, as the exhaust passage D, access to the nut is by way of an orifice sealed by a screwed plug E. Where it is expedient for a securing bolt to pass through a lateral passage to the exterior of the head it should, in the case of an exhaust passage, be shielded by a suitably streamlined casing cast across the passage. The nuts for the other two securing bolts are recessed into the floor of the valve rocker enclosure and sealed against oil leakage by screwed plugs. If the cylinder head is of light alloy the nuts may draw against cast-in steel rings F. *Patent No.* 710563. *Klockner-Humboldt-Deutz A.G.* (*Germany*).

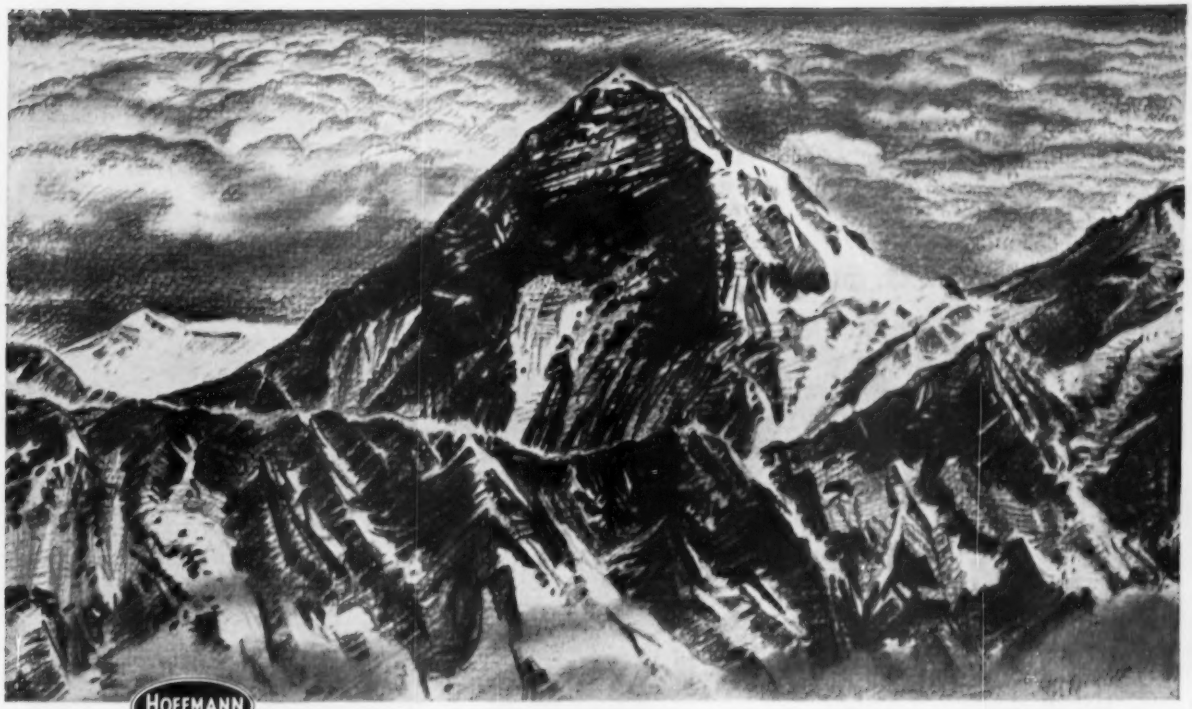


No. 711023

Precombustion chamber baffle device

TO suppress or mitigate the so-called "diesel knock" when an engine is idling, the familiar perforated or gapped baffle plate at the end of the transfer passage adjacent to the main combustion space may be replaced by an axially arranged rod which reduces the cross-sectional area of the passage and transforms its shape from circular to annular. This specification discloses a simple and reliable method of mounting such a rod concentrically in a passage.

Liner A, defining the precombustion chamber proper and the transfer passage, is arranged at an inclination to and offset from the cylinder axis. The tubular end of the liner protrudes slightly below the cylinder head face and terminates in a plane parallel to the face. Rod B, formed with an eye at its upper end, is suspended in the passage by a cross pin C and a second cross pin D arranged at right angles. On the lower end of the rod is a baffle disc D, lying parallel to the end of the liner and spaced to leave an annular throttling gap. This gap may be uniform, or of varying dimensions around the periphery of the disc to produce desired distributional effects. An advantage of this construction is that, for a comparable working life, the pin-type baffle can be made of a less highly alloyed material than is necessary for the conventional flat plate baffle. *Patent No.* 711023. *Daimler-Benz A.G.* (*Germany*).



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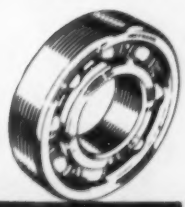

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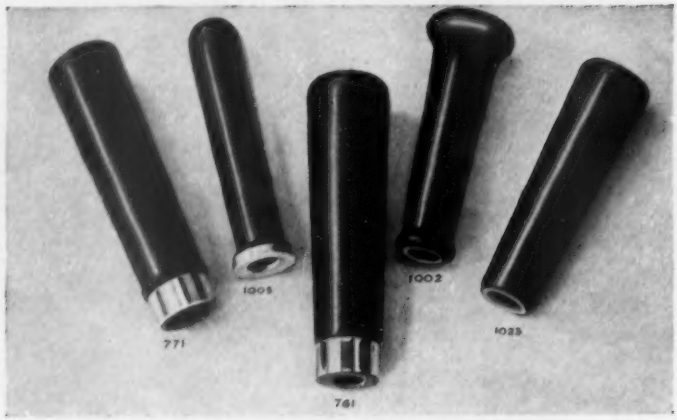

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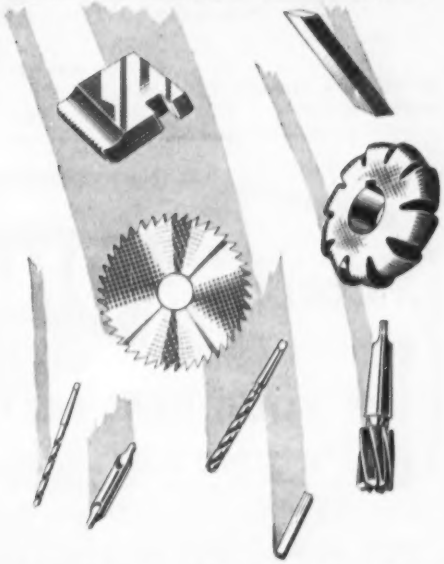

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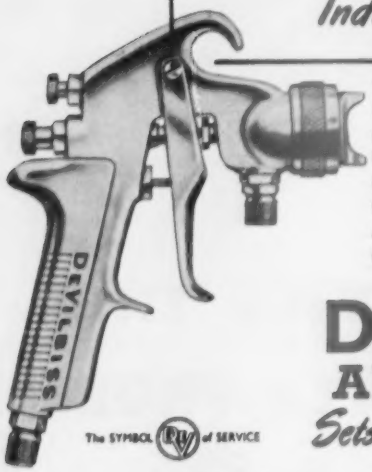

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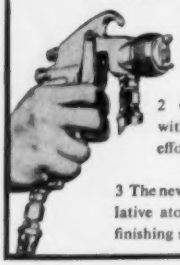

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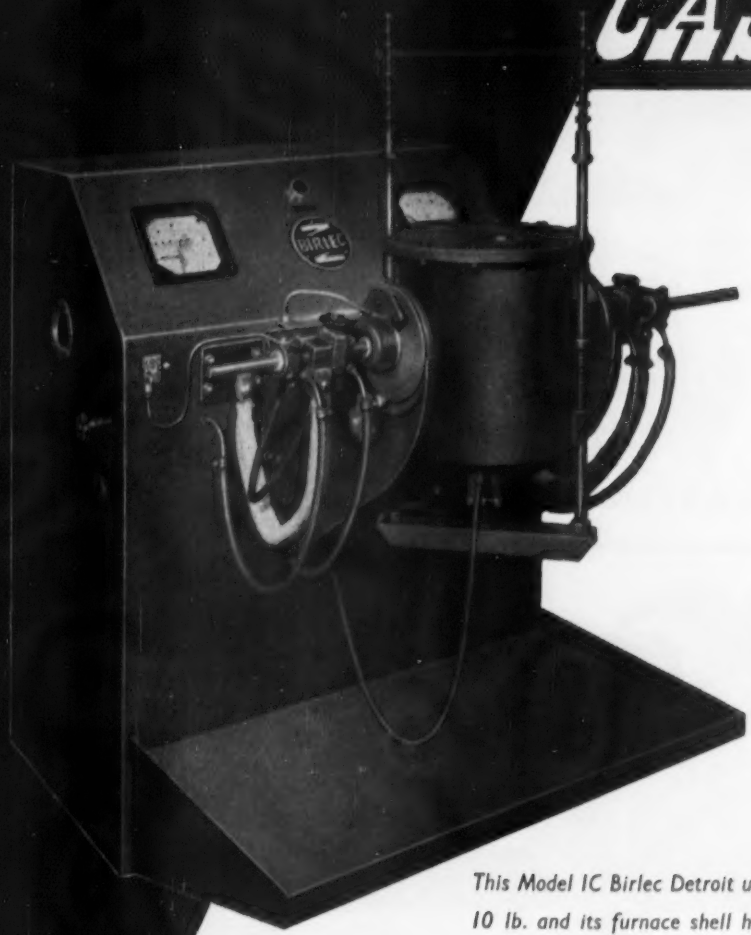

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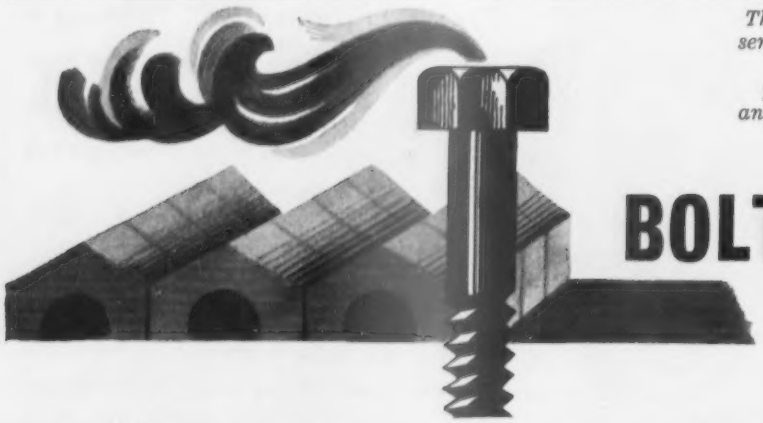

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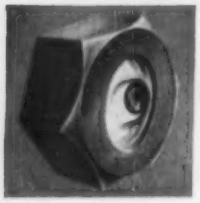

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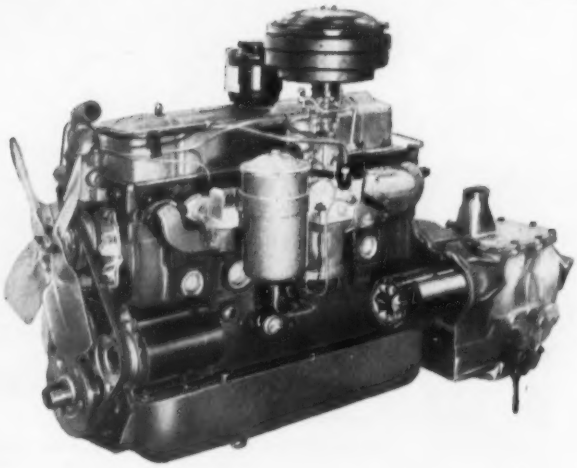

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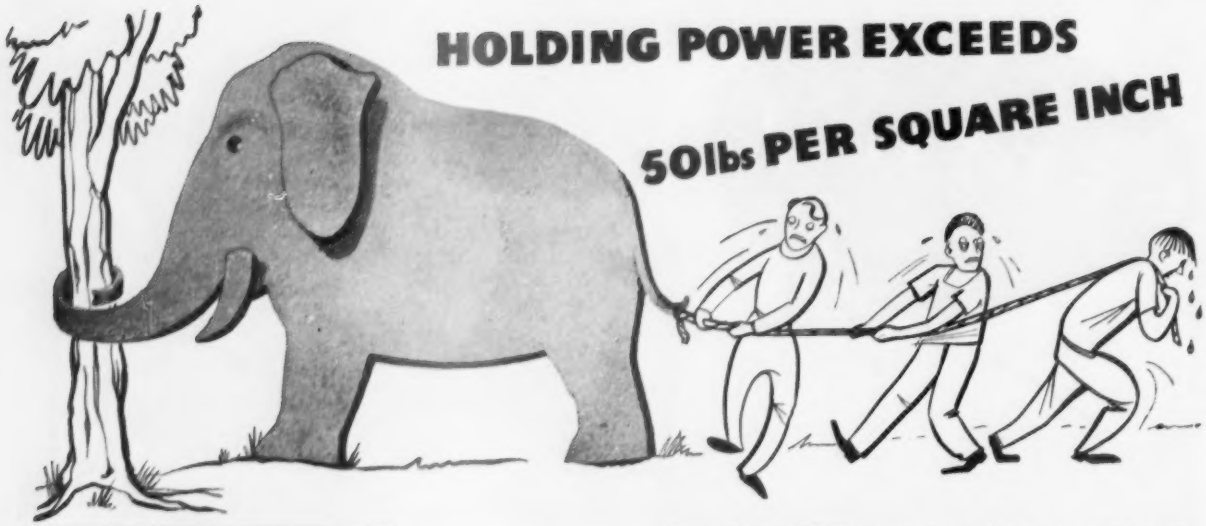

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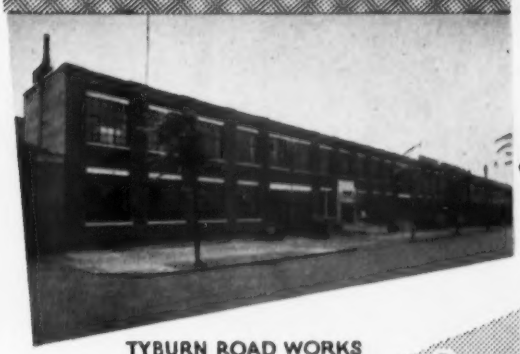

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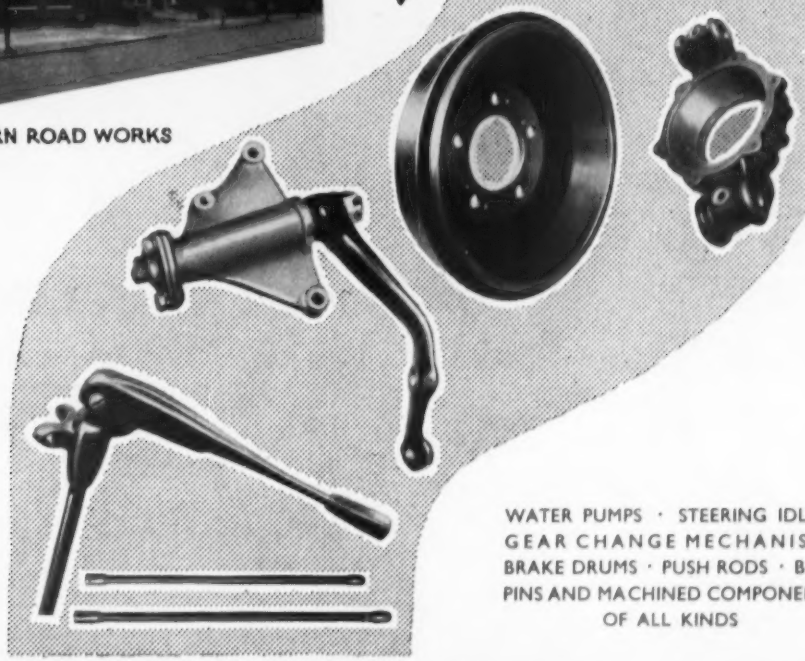

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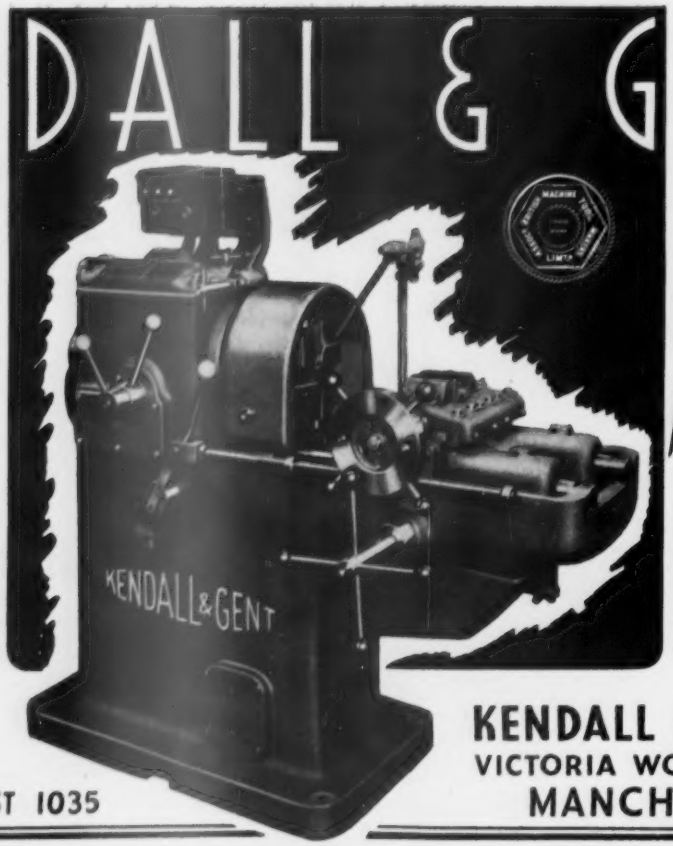

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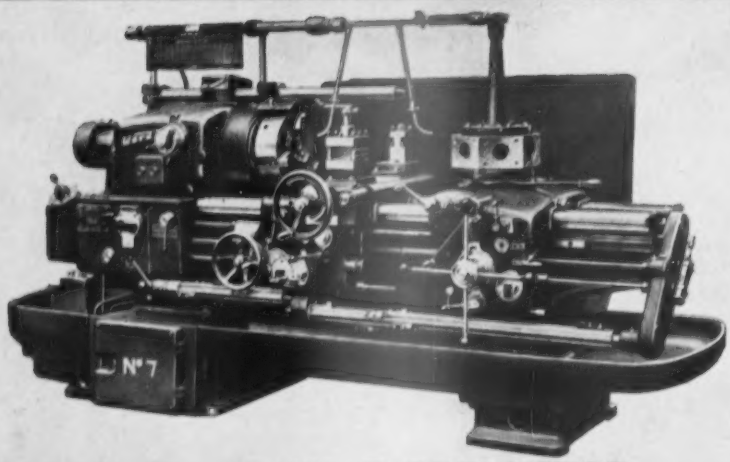

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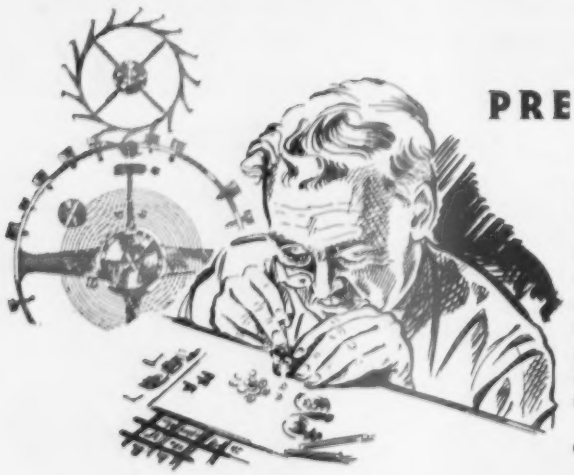

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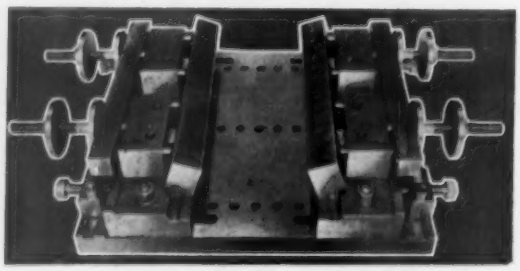

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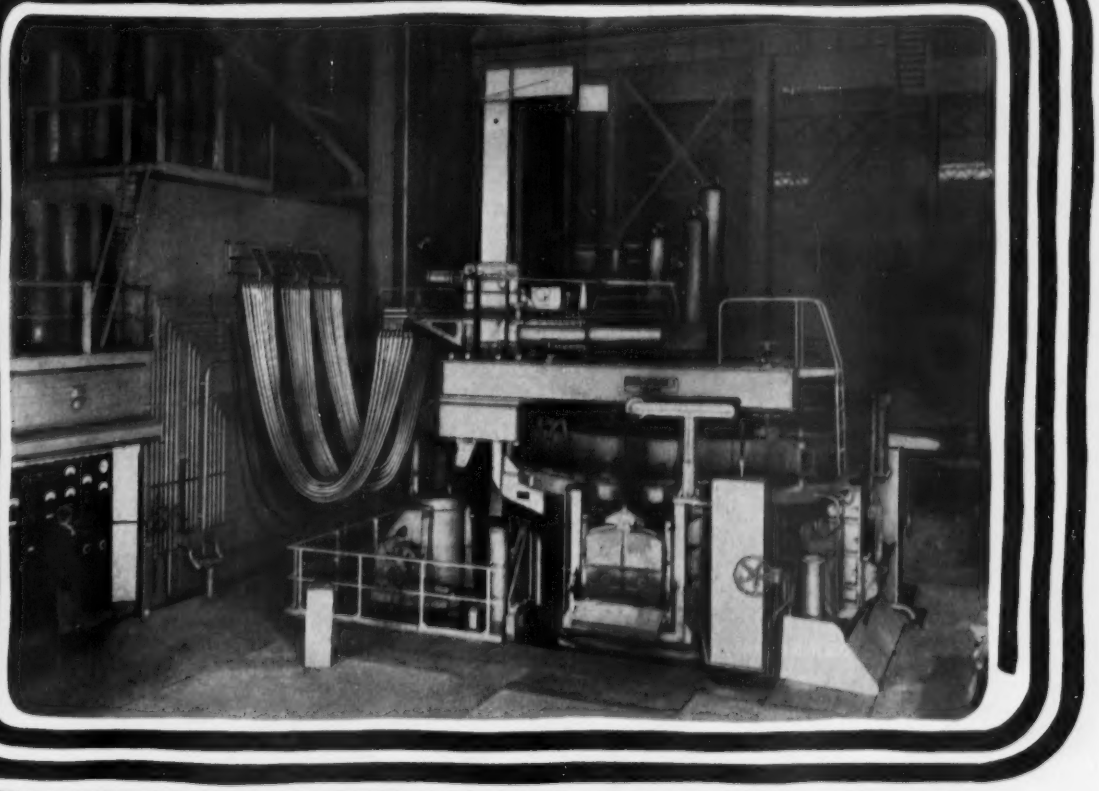

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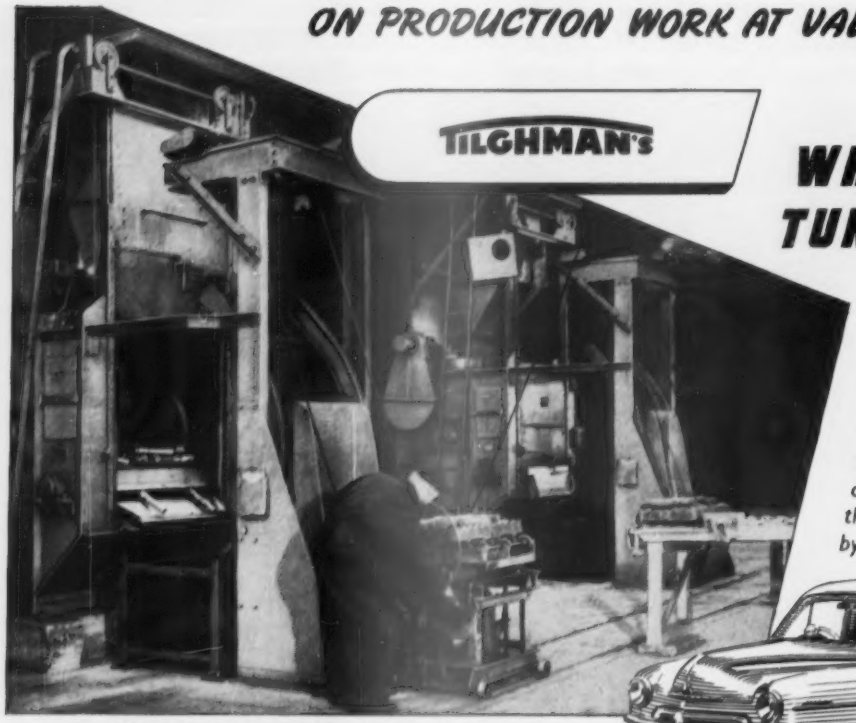

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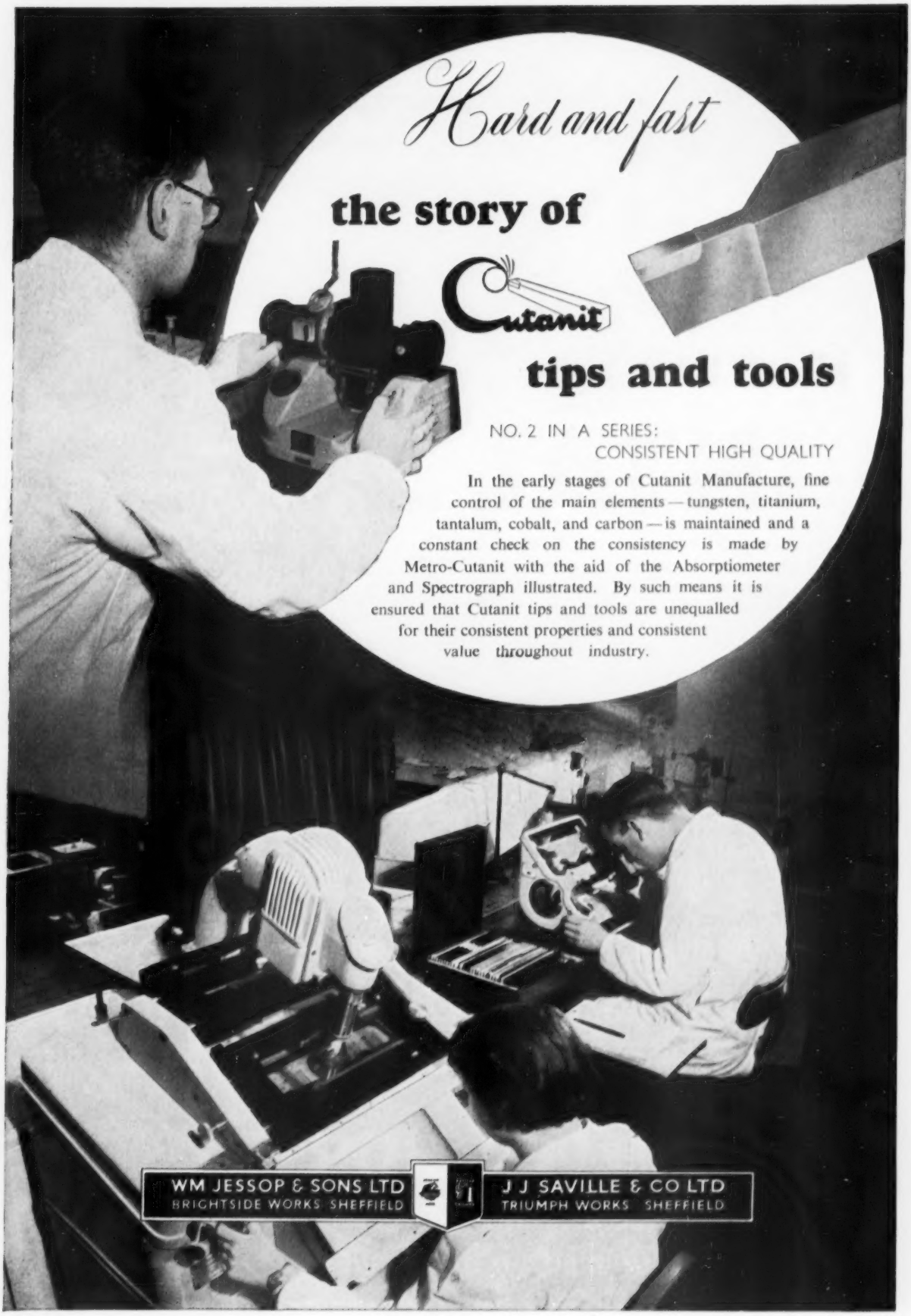
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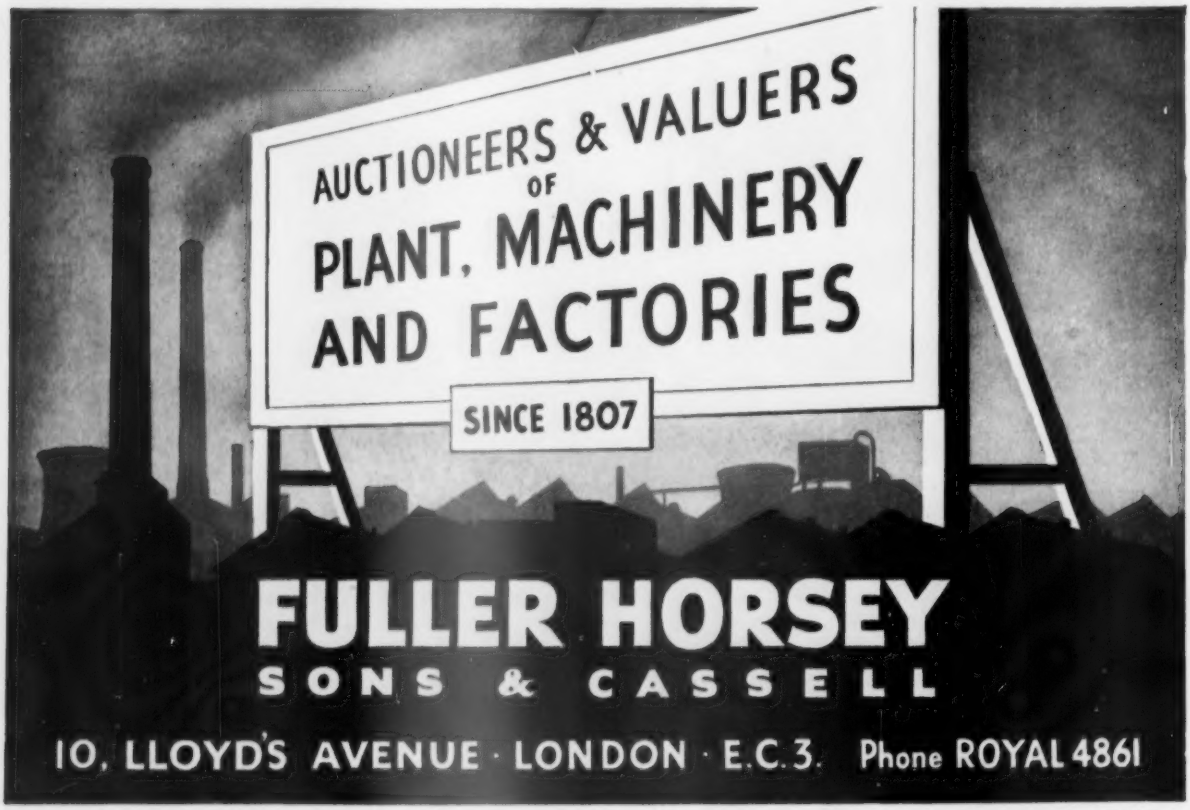
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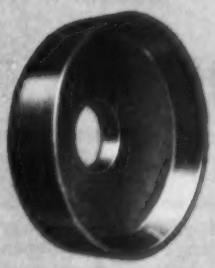

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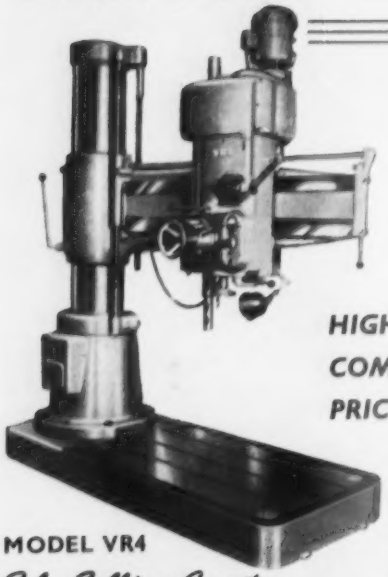

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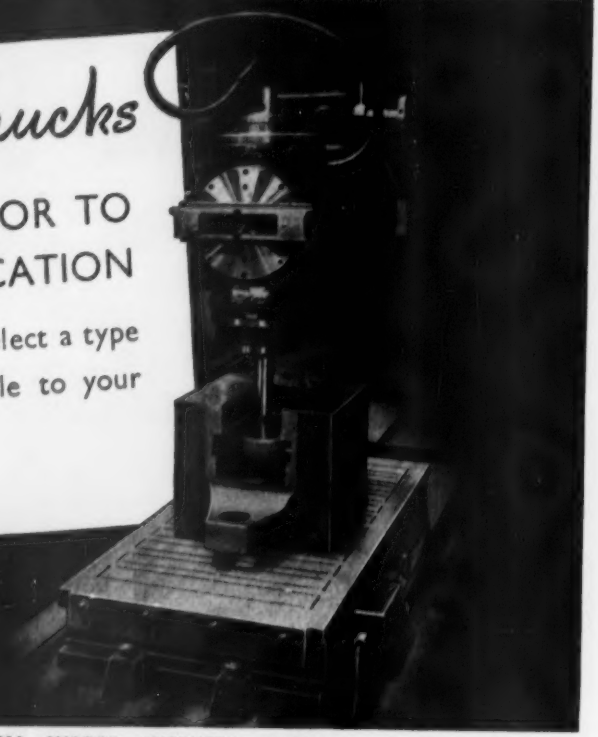

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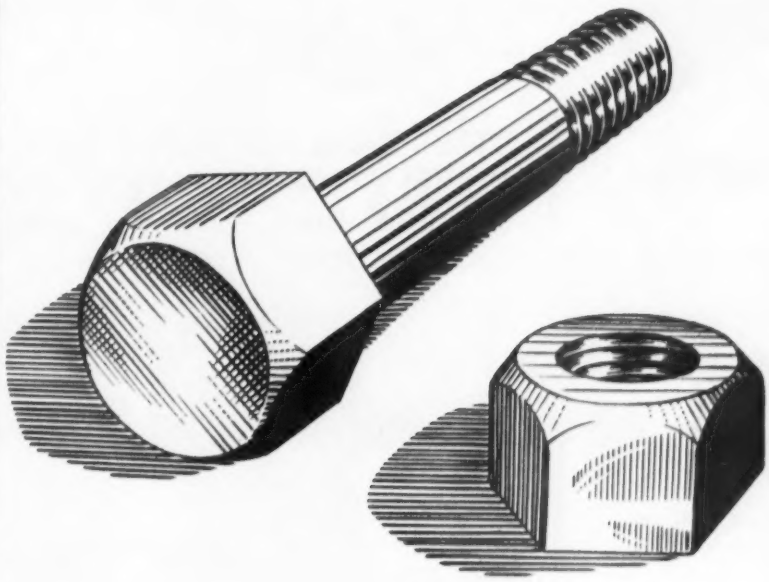

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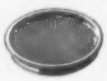
for over 25 years  in the production of filters strainers

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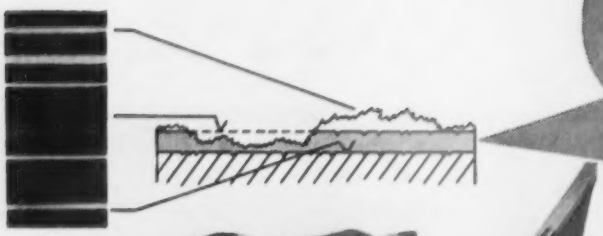

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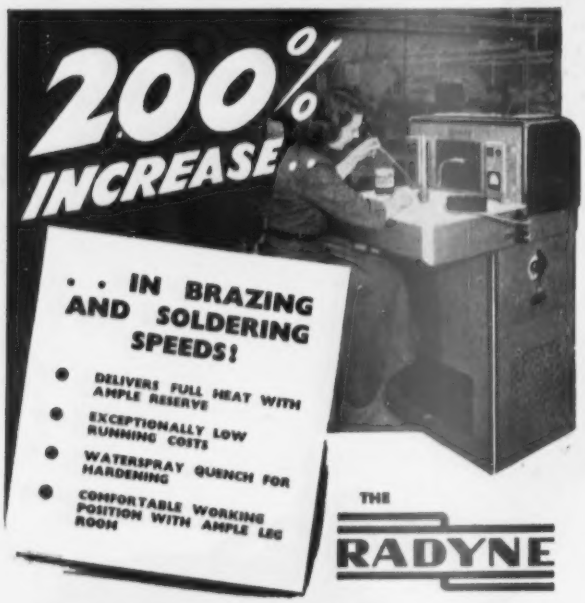
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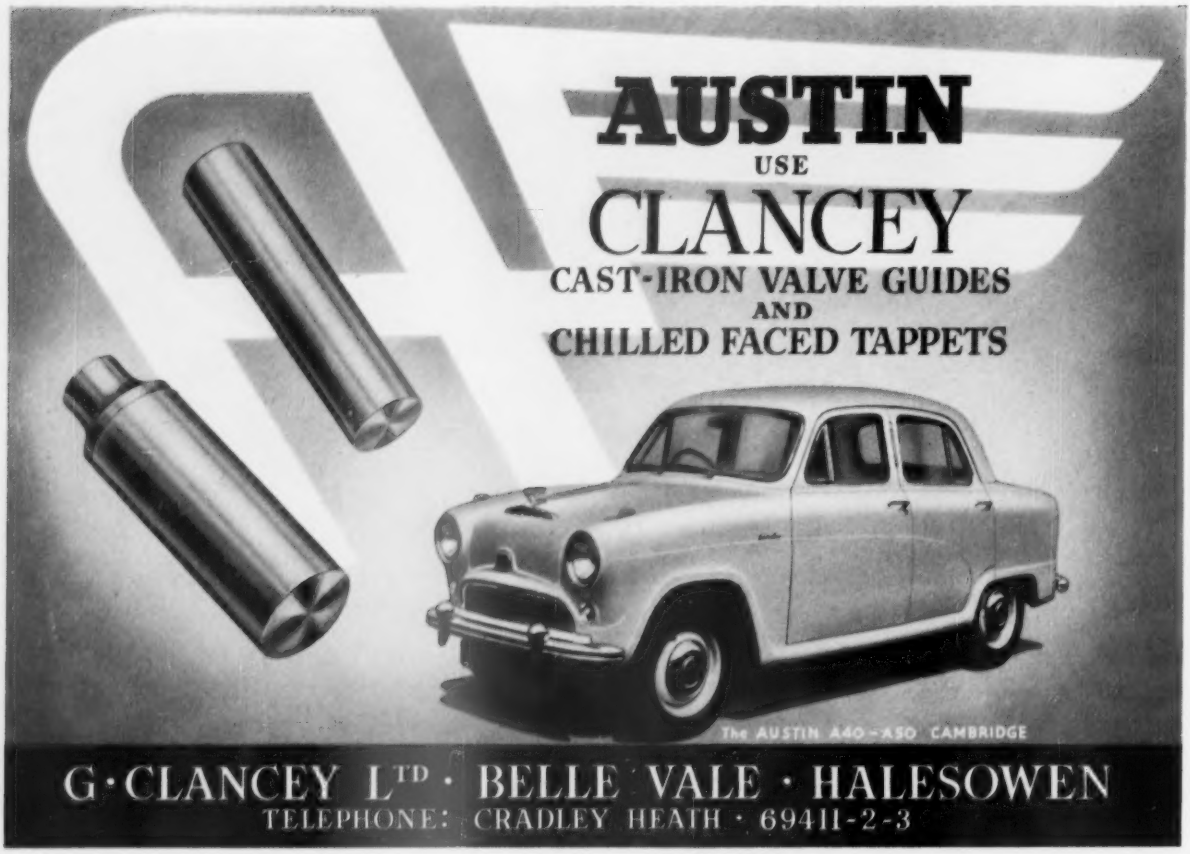

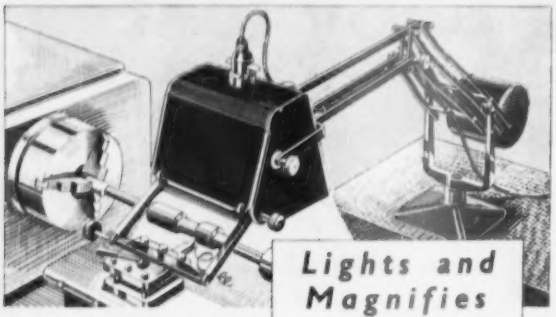

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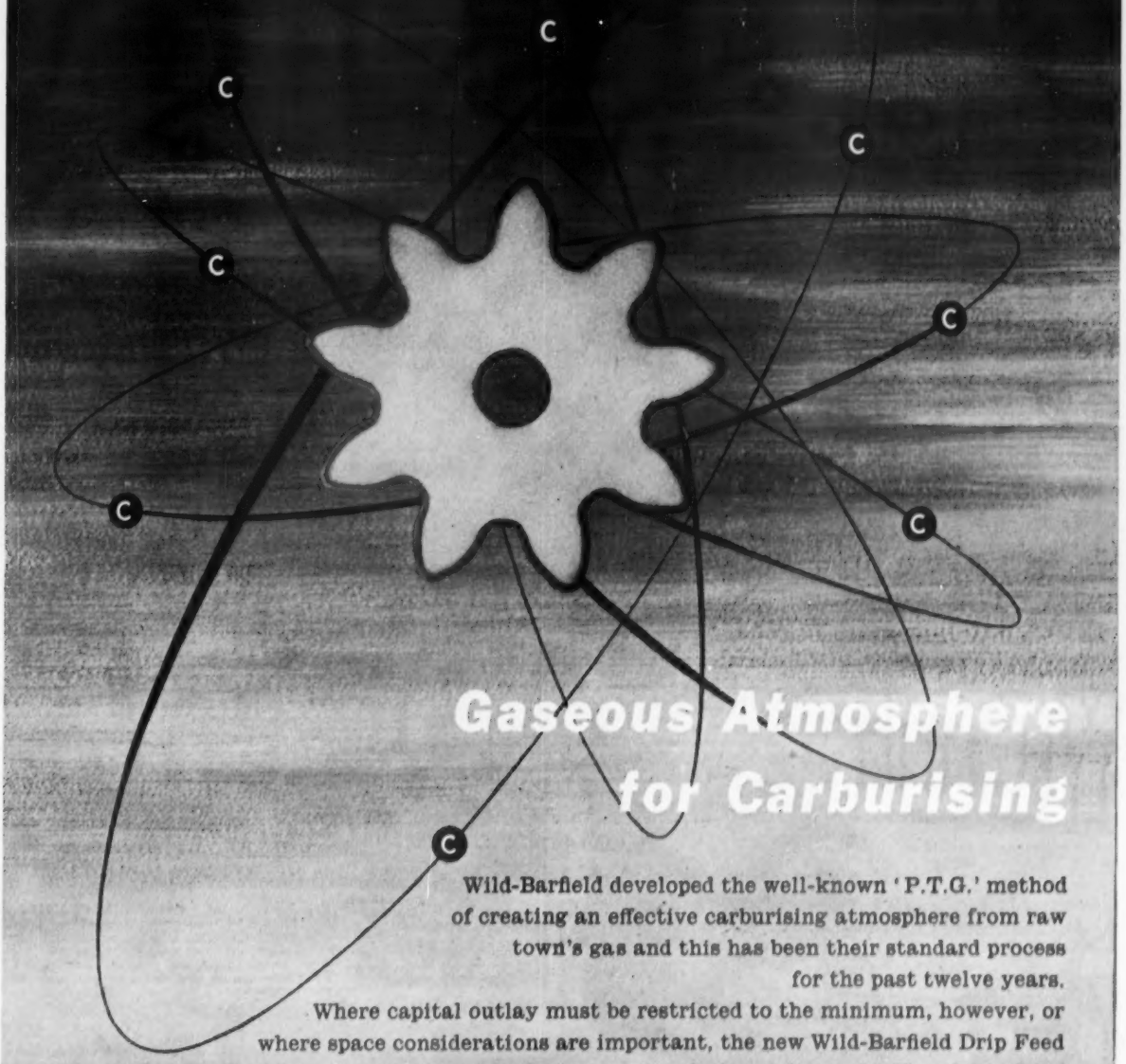

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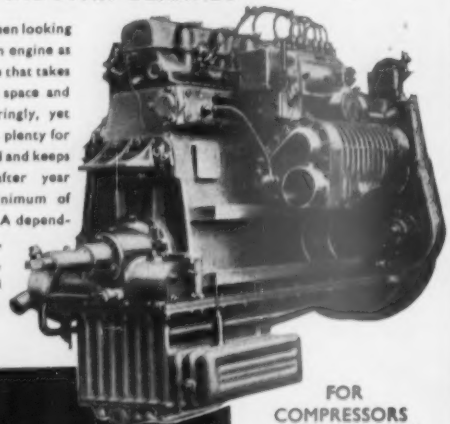

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From "Service Viewpoint", "The Autocar", 5th February, 1954

"... There seems to be no doubt that a quiet revolution is taking place in engine reconditioning circles. Despite the fact that the average car of today is somewhat elderly, the practice of reboring is gradually dying out, and the much less expensive remedy of 're-ringing' is leaping into favour. There are now four firms manufacturing piston rings designed expressly for use in a worn cylinder, and one of these firms has more than trebled its output since the war. This seems an inevitable trend, for, whilst piston rings and piston grooves are the most vulnerable of the engine's internals, bearings and cylinder bores are being made more and more durable, and vehicle operators are finding that heavy oil consumption owing to worn rings and grooves is not necessarily accompanied by serious wear in other departments: thus, much less *complete* engine overhauling is now considered essential, and the interim solution of re-ringing is being increasingly employed.

The cost factor must be considered these days; a complete overhaul for a so-called 10 h.p. engine will probably cost not less than £35, whilst a thorough decarbonization and valve-grind, plus re-ringing of the old pistons, would probably cost not more than £15. So that if the interim remedy were only 75 per cent as successful as a complete overhaul, the motorist would be on the winning side. If the costs of oil replenishment are taken into consideration, the motorist would gain even more, for oil control by special rings is infinitely more effective ..."

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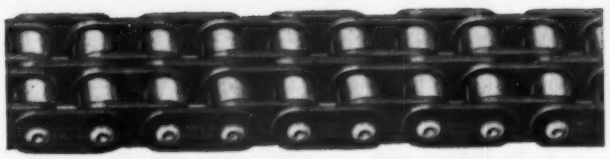

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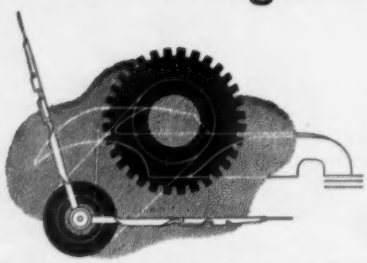

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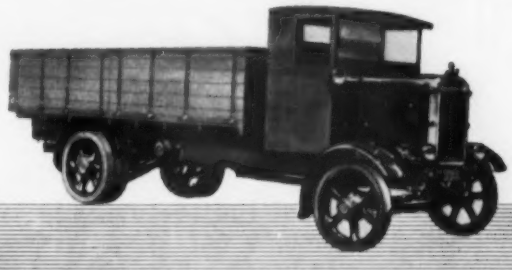

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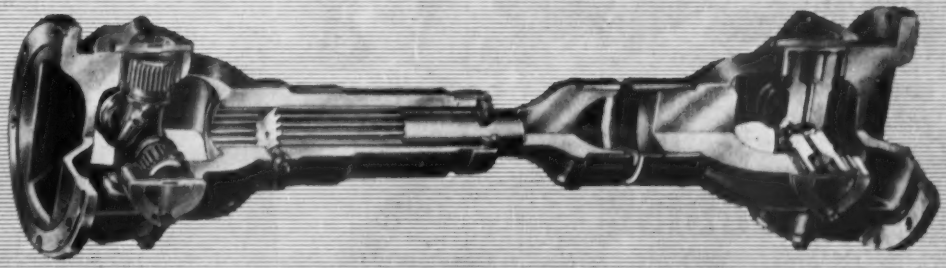

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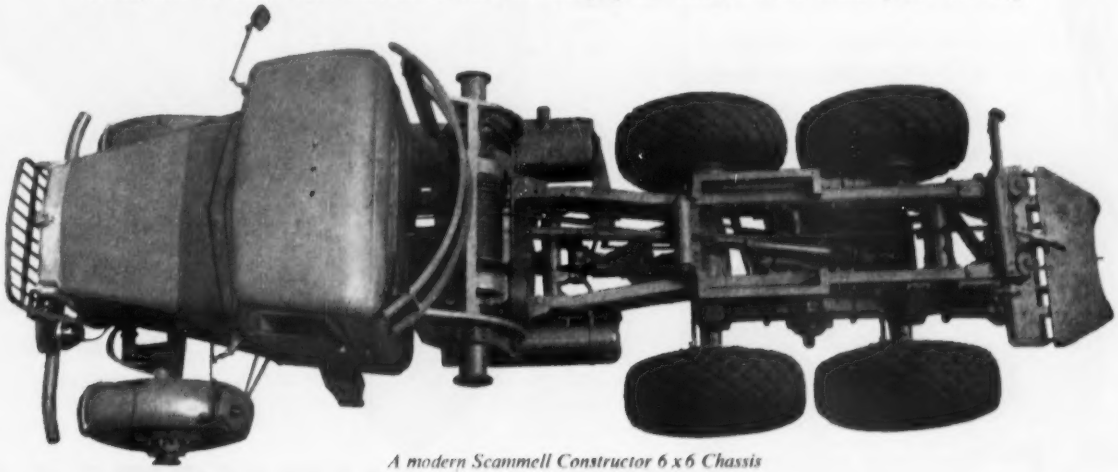

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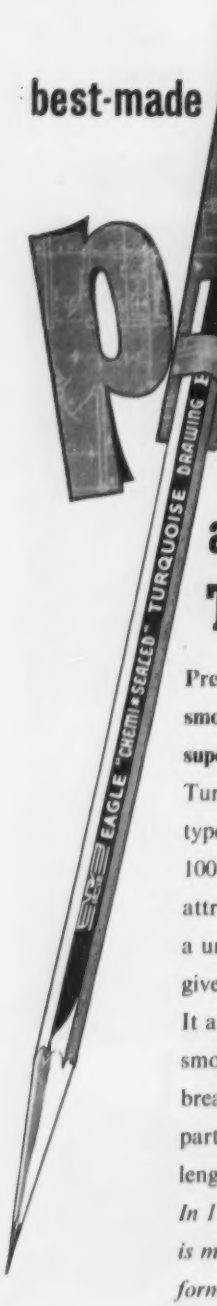

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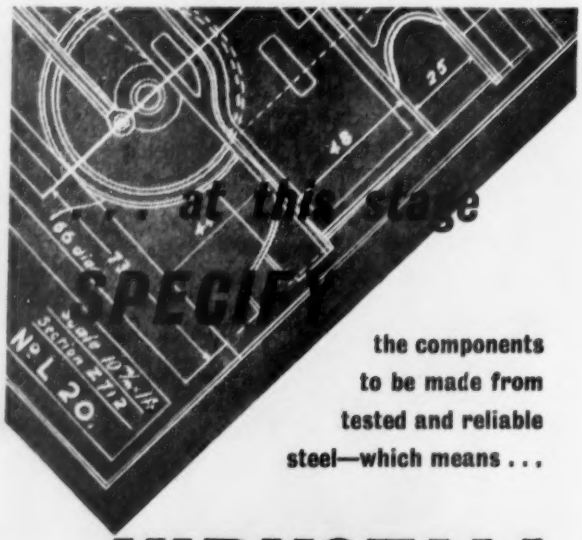

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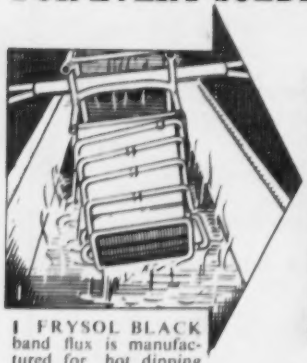

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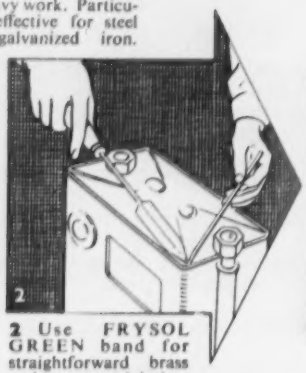

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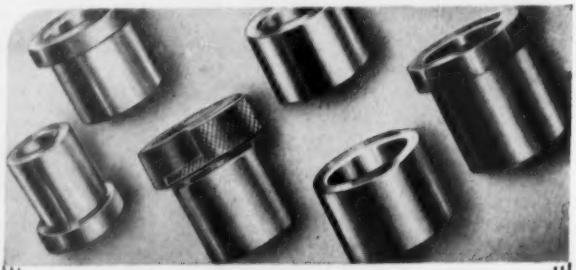

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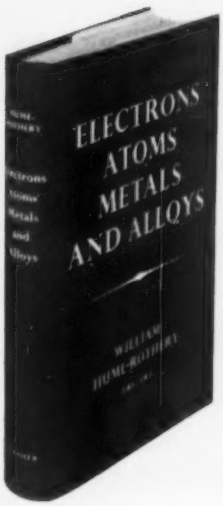

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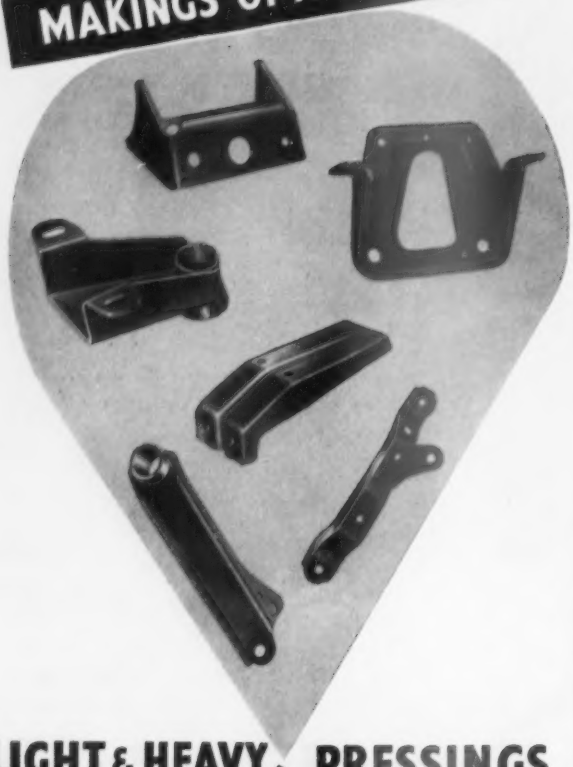

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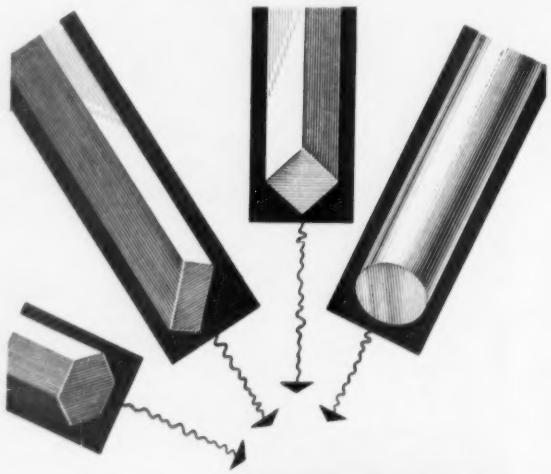

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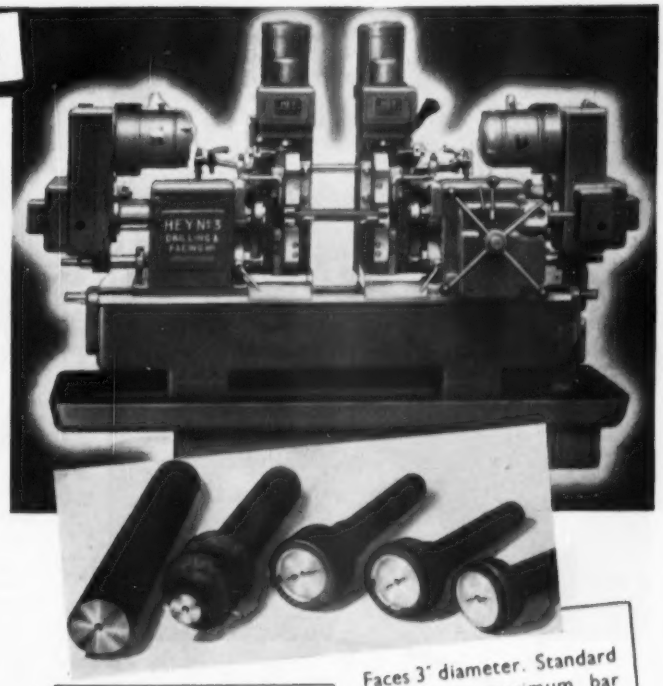

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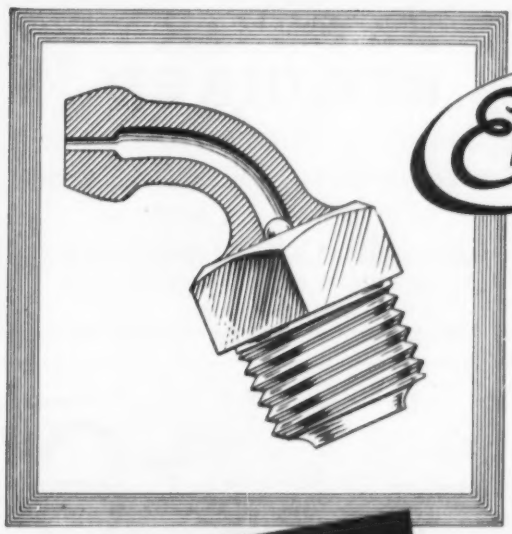

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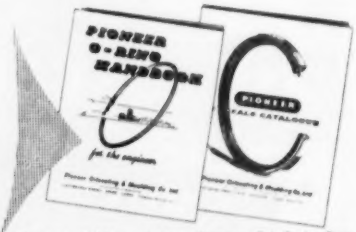

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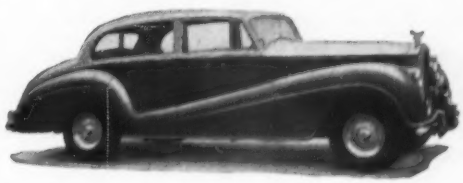

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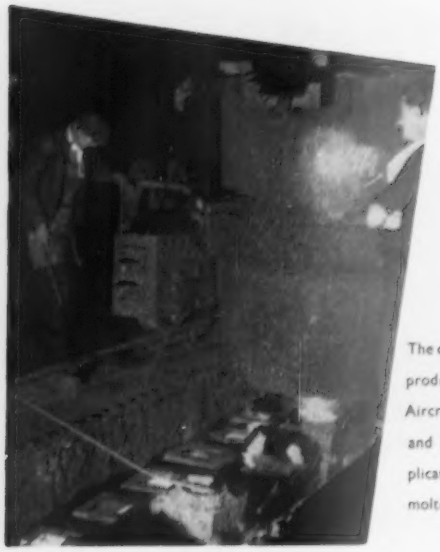

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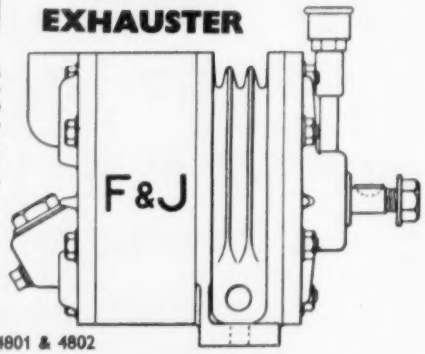

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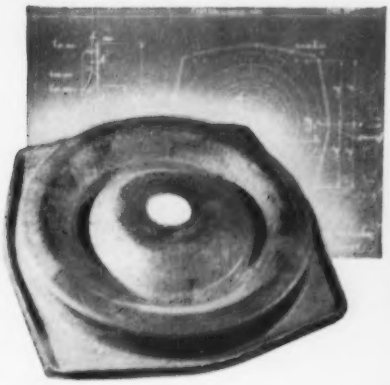

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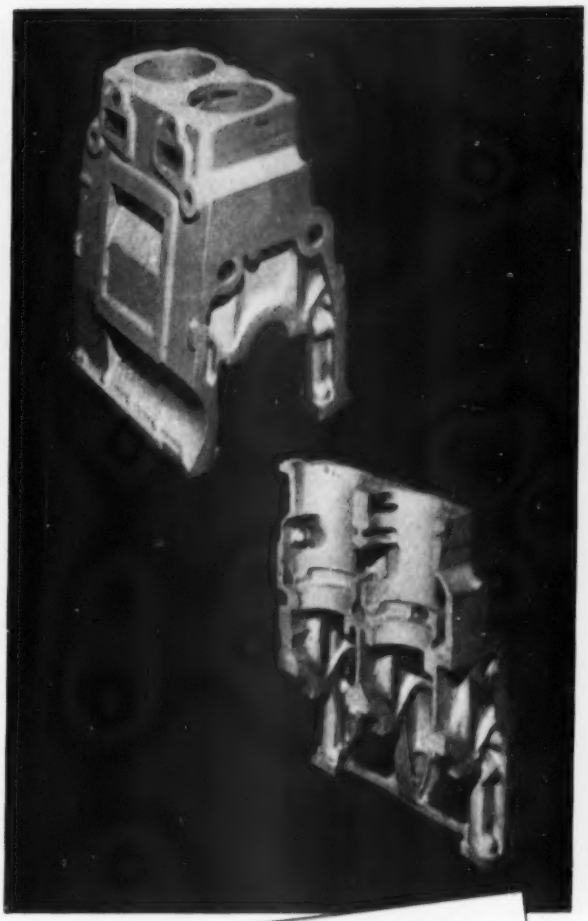

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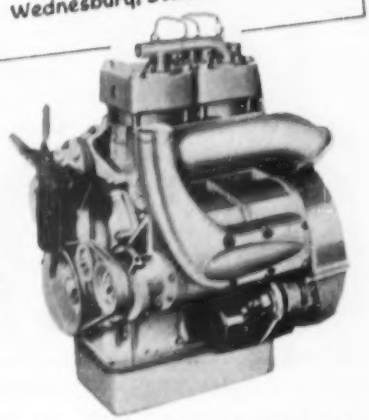

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G. L. BARNES, Secretary. [4988

SITUATIONS VACANT

The engagement of persons answering these advertisements must be made through the local office of the Ministry of Labour and National Service, etc., if the applicant is a man aged 18-64 or a woman aged 18-59 inclusive, unless he or she or the employer is excepted from the provisions of The Notification of Vacancies Order, 1952

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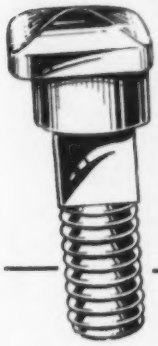

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AUTOMOBILE Engineer, A.M.I.Mech.E., wide experience on Chassis and Transmission Design and Development, Mechanical Engineering and Hydraulics, not afraid to work, seeks responsible position offering scope and good prospects. Age 41. Married. Living in Midlands. All replies acknowledged in confidence. Box 2240, c/o Automobile Engineer. [4980

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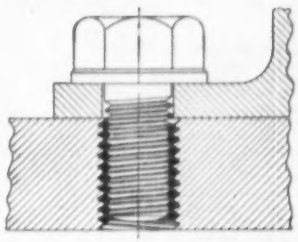

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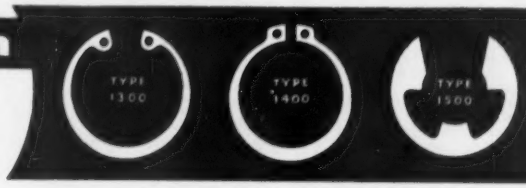

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